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PRELIMINARY REVIEW OF USED LUBRICATING OILS IN CANADA

by

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1. INTRODUCTION

The problem of waste lubricating oil is one that shares many features with the major resource and environmental concerns of our time. Like minerals and metals, lubricating oil is in its origins a non-renewable natural resource fundamental to the maintenance and growth of our society - and one that should be conserved. Like gasoline and fuel oil, it is essential to the operation of industry, power plants and transportation. And like other industrial and municipal wastes, used lubricating oil presents significant health and environmental hazards in its disposal.

This report presents a survey of the present situation in Canada including overall volumes, chemical compositions, current end-uses and disposal methods, and a brief look at existing legislation. It also examines the shortcomings of present methods and highlights promising areas of investigation.

Although it is intended to be a first step in an in-depth, nation-wide study by Environment Canada to assess the problems and recommend specific measures, it is hoped that it will also draw widespread attention to the problem of used lubricating oil. It is also hoped that it will enlist the interest of both governmental and industrial bodies in devising an effective system of collection, treatment, recycling and/or disposal of a substance that is, at the same time, a serious pollutant and a potentially valuable resource.

1. INTRODUCTION

Le problème posé par l'huile de lubrification usée s'inscrit dans le cadre des grandes préoccupations actuelles touchant les ressources et l'environnement. Tout comme les minéraux et les métaux, l'huile de lubrification est, à l'origine, une ressource naturelle non renouvelable indispensable à l'existence et à la croissance de notre société, une ressource qu'on doit conserver. De même que l'essence et le fuel-oil, elle est essentielle à l'industrie, aux centrales d'énergie et au transport. Son élimination, comme celle des autres déchets industriels et municipaux, constitue un grave danger pour la santé et l'environnement.

Ce rapport présente un aperçu de la situation actuelle au Canada, englobant les volumes totaux, les compositions chimiques, les usages finals et les méthodes d'élimination courants, ainsi qu'une brève revue de la législation existante. Il met également en lumière les lacunes des méthodes actuelles de même que les domaines de recherche prometteurs.

Il ne constitue qu'une première étape d'une étude nationale menée en profondeur par Environnement Canada en vue d'évaluer le problème et de recommander des mesures précises. Nous espérons toutefois qu'il saura retenir l'attention générale sur le problème de l'huile lubrifiante usée. Nous espérons également qu'il incitera le gouvernement et l'industrie à élaborer un système efficace de récupération, de traitement, de recyclage et d'élimination d'une substance qui est à la fois un polluant dangereux et une ressource naturelle utile.

2. SUMMARY OF THE REPORT AND RECOMMENDATIONS

Although this review of used lubricating oils in Canada seeks to present the salient features of a major national problem, it is in no way an exhaustive study. In certain cases, in the absence of specific data on Canadian conditions, it has had to draw on the findings of American and European studies. In others, assumptions have had to be made against the day when a nation-wide investigation can supply hard data.

It is hoped, nevertheless, that it will prove an accurate and useful guide to the waste lubricating oil situation in Canada and will provide practical approaches for solving the problem.

The body of the report falls into four major areas:

1) The Magnitude of the Waste Oil Problem which supplies figures on the volumes involved and a breakdown into major use categories;

2) Waste Oil Storage and Collection which indicates the usual methods of storing, collecting and distributing used oil;

3) Present End-uses which outlines current methods of utilization and disposal from road oiling to recycling; and

4) Existing Legislation which looks at federal, provincial and municipal regulations regarding waste oil.

The list of reference materials and the attachments at the back can be consulted for the sources of the data cited in this report.

That the problem of used lubricating oil is a major one can be seen immediately from the figures. Of the approximately 188 million gallons sold (1972 figures) each year, up to 80 million gallons end up in the category "waste oil", a black, dirty liquid that in one way or another has to be utilized, disposed of or destroyed.

As the report shows, this is no easy task. Lubricating oil is a sophisticated preparation which is becoming more complex with the increasing demands being made by modern engines and machinery. To meet higher operating temperatures, increased bearing loads, and to provide longer operating life, lubricating oil has to be blended with a wide

range of additives. These chemical and metallic compounds, especially when combined with the contaminants picked up in use, are very difficult to remove. If, however, they are left in the oil at the time of disposal, they make it a serious pollutant.

Compounding the problem is the fact that present collection systems are both primitive and non-selective. For large segments of the oil-use spectrum, such as do-it-yourself oil changers, small businesses, farms etc., no adequate retrieval or storage systems exist at all. The oil is simply disposed of in the most convenient way for the user. For the oil that is collected, such as that from franchised service stations, truck fleets, large industries etc., no segregation into different types is practised and most of it is randomly mixed with the residues of other liquid wastes, thereby contaminating it further.

Only a small proportion of waste lubricating oil, 5-6 million gallons a year, is currently being re-refined and put back into service. Most contaminated oil is simply dumped into roads as a dust suppressant, blended with fuel so that it can be burnt, or released into sewers.

If used oil were an innocuous substance that would decay easily there would be little cause for concern. The fact is, however, that it contains hazardous substances that biodegrade slowly or not at all. This means that in practice contaminants are simply being put into the environment. How much, can be seen from the figures in this report. Of the millions of tons of waste oil deposited on the roads to control dust, only 1% of the total actually remains on the road. The rest finds its way into the fields and water systems of the surrounding land, into the vegetation and livestock, and ultimately into our food. If, on the other hand, all the used lubricating oil produced each year in Canada were burnt, it would release up to twelve million pounds of metallic oxides in submicron size (easily ingestible) into the air and subsequently onto the surrounding land areas. If dumping or burning were the only alternatives, the outlook would be bleak indeed. For neither decay nor burning can destroy the major contaminants in oil. The toxic heavy metals suspended in waste oil are submicron in size and do not subside into a residue. If the oil is burnt, they are simply carried out by the released gases. The polynuclear aromatics in waste oil, (PNA's)

which have been linked to cancer in animals, cannot be destroyed by temperatures less than 2,600°F and will simply spread through soil or be carried by the air whichever method of disposal is chosen.

Obviously the two most common methods, combustion and dumping are both unsatisfactory and hazardous. At best they are simply diluting pollution by spreading it around.

One major form of combustion of raw lubricating oil that shows promise is in its use in cement kilns. In this process contaminants are absorbed by the clinker in the kiln and are thereby trapped and sealed in a non-hazardous product. As the report indicates, the process needs further investigation before it can be determined whether it can be utilized on a large scale as a solution to the waste oil problem.

The most satisfactory answer - and one that is economically and ecologically desirable - is the treatment and/or recycling* of waste oil. Before oil is used either as a fuel or as a dust palliative it should be treated to remove contaminants. But for treatment to be economical and effective, the oil must be collected in a manner that minimizes the possibilities of contamination over and above that which has occurred in normal use. If oil is to undergo the further step of being re-refined, not only must the collection be done in a manner that does not unnecessarily contaminate the waste oil but also the different types of lubricating oils have to be kept segregated. In this way, even if the oil cannot be re-refined back into its original form, there is a good chance that it can be processed to perform a different lubrication or fuel function. The present random mixing of all types of waste oil and other organic liquids renders re-refining a difficult and costly process.

Nevertheless, as the Canadian Pacific Railway and the STELCO Hilton plant in Hamilton, Ontario have discovered, recycling of waste oil can be an economically attractive procedure. Approximately 22% of the CPR's diesel locomotive oil is composed of recycled lubricating

* In the oil industry the term "recycle" is used to cover any alternate use of waste oil.

oil. At the STELCO plant recycled oil is being blended with No. 6 oil and used in the hot strip preheating furnace.

In contrast is the case of the two major national users controlled by the Federal Government. The Canadian National Railways has only recently begun recycling a small portion of its used oil and the Department of Defence, has not, as yet, instituted measures which will give it the benefits of re-refining its waste oil.

Even more serious, current federal taxation is actually inhibiting a wider application of re-refining by imposing a tax on oil that has been re-refined, blended with additives and supplied to a purchaser other than the original user. In Germany and Italy, by comparison, government rebates are given to companies that treat and re-refine waste lubricating oil.

The survey of current legislation included in this report is not exhaustive, but, even so, it reveals that much is lacking at all levels of government in the adequate control of waste oil collection, storage, handling and end uses. This is particularly true in the matter of road oiling. A rationalized system will most certainly require uniform and comprehensive regulation with nation-wide coverage to be effective.

The problem of waste oil has been with us for a long time. It has been part of the dark side of the wheels of progress. Now it has reached such proportions that it cannot be overlooked any longer. Like most of the advances of our technological society, an improvement in convenience or efficiency in one area is matched by a problem or disadvantage in another.

To enjoy the enhanced performance, viscosity and operating life of modern oils, we have to face the fact of more hazardous by-products and residues. Equally as serious in a period when seemingly limitless resources have suddenly become finite and precious, used oil represents an irreplaceable natural resource that is simply being wasted. That it is being wasted in a manner that is poisoning our environment should be a matter of widespread concern.

Recommendations

The following recommendations are the outcome of the findings of this survey and are designed to provide a basis for effective measures to bring the problem of waste lubricating oil under control. For more detailed suggestions and more specific analyses, see the individual sections and sub-sections of the report.

1) Used lubricating oil studies should be carried out in each province to determine:

    a) volumes of different oils available,
    b) collection system existing and needed,
    c) disposal, means of recycling or end uses,
    d) legislation and/or regulations needed to control and channel used oil into desired collection system through to end use or ultimate disposal.

The above work should be done by the environmental authorities in conjunction with provincial petroleum associations and other firms or associations involved in waste oil collection, end-uses or ultimate disposal.

2) Alternate means of controlling dust on unpaved roads should be investigated. As a first step, the use of "untreated" oil as a dust pallative should be stopped. In the interim use of oils, properly "treated" to remove heavy metals, low flash point components and water should be applied only by licensed operators who are regulated with respect to:

    a) quality of the oil to be used,
    b) quantity of oil to be used,
    c) method of application.

3) Burning for the sake of thermal destruction should be the last alternative for disposal and should only be done when adequate air pollution abatement facilities are present. A utilitarian end-use for waste oil should be the objective, whether it be recycling, heat recovery or other use.

4) All major sources of used lubricating oil should have adequately-sized, properly designed storage tanks, to ensure collection and segregation. Such places would be service stations, railway yards, bus garages, truck garages, electrical generating and transformer locations, marine depots, airports, industrial plants, large refrigeration or air conditioning units, military bases, etc., etc. These sites need to adopt the rule that segregation is the first step, and a very important one, in any disposal process.

5) Smaller locations should be required to store used oil in approved storage containers (e.g. under specifications similar to the Ontario Gasoline Handling Act).

6) All locations (as identified in numbers 4 and 5) having used oil should have adequately designed and maintained dirt, water, oil, interceptors for their aqueous effluent, regardless of whether the discharge is or is not to a municipal sanitary sewer. As an interim standard, the oil content of aqueous discharges to municipal sanitary sewers should be limited to a maximum of 50 - 100 ppm. If discharge is into a storm sewer, plans should be formulated for connection to a sanitary sewer.

7) Used oil recycled for fuel should be properly treated to remove metallic impurities prior to blending with other fuels or burned in a manner that does not cause pollution. A potential major water pollutant should not become an air pollutant under the guise that "dilution is the solution".

8) All retail lubricating oil sales outlets should provide either returnable containers for carry away oil sales and/or a collection point for used oil on their property for their own customers.

9) Federal, provincial and municipal government departments and agencies should take inventory of their lubricating oil buying and disposal practices. They should review the possibilities of recycling and re-refining used oils by specifying the desired properties of products (e.g. hydro electric companies and municipal utilities could have transformer oil re-refined specifying the desired

dielectric constant, interfacial tension, neutralization number etc., etc.).

10) Significant government support (financial, technical, regulatory etc.) should be given to the desired collection system through to end use or ultimate disposal (e.g. return of the Federal Sales Tax to the 1967 status for re-refined oils or even rebates on the German model.)

2. RÉSUMÉ ET RECOMMANDATIONS

Le présent rapport sur l'huile de lubrification usée au Canada vise à mettre en évidence les éléments principaux d'un problème national d'importance et ne constitue aucunement une étude exhaustive. Dans certains cas, en l'absence de données précises sur la situation canadienne, nous avons dû utiliser les résultats d'études américaines et européennes. Dans d'autres cas, il nous a fallu émettre des hypothèses en attendant le jour où une étude menée à l'échelle nationale pourra fournir des données sûres.

Cependant nous espérons qu'il sera un guide précis et utile sur la situation de l'huile de lubrification usée au Canada et fournira des solutions pratiques à ce problème.

Le rapport se divise en quatre parties principales:

1) L'etendue du problème de l'huile usée, qui présente des données sur la quantité utilisée et sa répartition dans les diverses catégories;

2) La récupération et l'emmagasinage de l'huile usée, qui indique les méthodes couramment utilisées pour la récupération, l'emmagasinage et la distribution de l'huile usée;

3) Les usages finals actuels, qui énumère les méthodes habituelles d'utilisation et d'élimination, du huilage des routes au recyclage; et

4) La législation actuelle, qui étudie les règlements fédéraux, provinciaux et municipaux au sujet de l'huile usée.

Pour obtenir les sources des données utilisées dans le présent rapport, prière de consulter la bibliographie et les annexes.

Il suffit d'étudier les données pour constater que le problème posé par l'huile lubrifiante usée est sérieux. Des quelque 188 millions de gallons vendus chaque année (d'après 1972), on compte 80 millions de gallons qui finissent par être rangés dans la catégorie "huile usée", soit un liquide noir, fortement contaminé, qui doit absolument être utilisé, éliminé ou détruit.

Ce n'est pas là une tâche facile. L'huile de lubrification est un mélange complexe qui le devient de plus en plus pour répondre aux exigences des moteurs et de l'outillage modernes. Pour lui permettre de résister aux températures élevées, aux charges accrues et pour lui assurer

une plus longue durée, on doit ajouter à l'huile une grande variété de substances. Ces composés chimiques et métalliques sont très difficile à extraire, et plus spécialement lorsqu'ils sont combinés aux contaminants incorporés au cours de l'utilisation. Ils constituent un polluant très dangereux s'ils sont présents dans l'huile au moment de l'élimination.

Le fait que les systèmes de récupération utilisés soient si peu perfectionnés vient encore aggraver le problème. De plus, dans le cas de nombreuses utilisations de l'huile, telles la vidange de l'huile effectuée par les particuliers, dans les petites entreprises, les fermes, etc., il n'existe aucun système de récupération ou d'emmagasinage approprié. L'usager élimine l'huile selon ses propres moyens. Dans le cas de la récupération de l'huile des station-service (concessionnaire), des entreprises de camionnage, des grosses industries, etc., on ne fait aucune distinction entre les différents types d'huile, et la plus grande partie de cette dernière est mélangée avec les résidus d'autres liquides, ce qui la contamine davantage.

Il n'y a qu'une petite quantité de l'huile lubrifiante usée, de 5 à 6 millions de gallons par année, qui soit régénérée et réutilisée. La plus grande partie de l'huile contaminée est simplement déversée sur les routes pour retenir la poussière, mélangée avec de l'essence et brûlée ou jetée aux égouts.

Si l'huile usée était une substance inoffensive, se décomposant facilement, il n'y aurait pas là de quoi s'alarmer. Toutefois, le fait est qu'elle contient des substances dangereuses qui se dégradent lentement ou pas du tout. Ce qui signifie qu'en pratique, les contaminants sont tout simplement répandus dans l'environnement. Pour savoir dans quelles proportions, il suffit de consulter les tableaux du rapport. Des millions de tonnes d'huile usée déposées sur les routes pour retenir la poussière, il n'y en a que 1% qui y demeure. Le reste se répand dans les champs et les cours d'eau de la région environnante, ands la végétation et dans le bétail et finalement, dans notre nourriture. D'un autre côté, si on faisait brûler toute l'huile usée produite chaque année au Canada, elle libérerait dans l'air et, par conséquent dans les zones avoisinantes jusqu'à douze millions de livres d'oxydes métalliques (particules microscopiques qui

peuvent être avalées facilement). Si le déversement et le brûlage étaient les deux seules solutions, il n'y aurait pas grand espoir; car ni la décomposition, ni le brûlage ne peuvent détruire les contaminants contenus dans l'huile. Les métaux lourds toxiques en suspension dans l'huile usée sont sous forme microscopique et ne se transforment pas en résidu. Si l'huile est brûlée, ils sont emportés par les gaz libérés. Les aromatiques polycycliques contenus dans l'huile usée qui ont été reliés au cancer chez les animaux, ne peuvent être détruits par des températures inférieures à 2,600°F et vont se répandre dans le sol ou dans l'air, quelle que soit la méthode d'élimination choisie.

Il est évident que les deux méthodes les plus couramment employées, la combustion et le déversement, sont également insatisfaisantes et dangereuses. Au mieux, elles ne font que diluer la pollution en la répartissant.

Toutefois, il existe un procédé de combustion de l'huile de lubrification brute qui pourrait s'avérer avantageux, la combustion dans des fours à ciment. Grâce à ce procédé, les contaminants sont absorbés par le clinker dans le four, produit non dangereux d'où ils ne peuvent plus s'échapper. Comme vous pouvez le constater à la lecture du rapport, il faudra étudier plus à fond ce procédé avant de décider si l'on peut généraliser son application afin de résoudre le problème de l'huile usée.

Il n'en reste pas moins que la solution la plus satisfaisante, et qui est également désirable du point de vue économique et écologique, est apportée par le traitement ou le recyclage* de l'huile usée. Avant d'utiliser l'huile comme combustible ou pour retenir la poussière sur les routes, il faudrait la traiter afin d'en extraire les contaminants. Pour que le traitement soit économique et efficace, on doit utiliser pour la récupération de l'huile, un procédé qui réduise les risques de contamination supplémentaire. Si l'huile doit être régénérée, il faut en plus séparer les différents types d'huile de lubrification. De cette manière, même si l'huile ne peut être rendue à sa forme originale, il est possible qu'elle puisse servir à d'autres usages. Le mélange de tous les types d'huile usée avec d'autres liquides organiques pratiqué actuellement augmente

* Dans l'industrie, le terme recyclage englobe toutes les utilisations de l'huile usée.

la difficulté et le prix de la régénération.

La société de chemin de fer Canadien Pacifique et l'usine Hilton de STELCO à Hamilton, en Ontario, ont découvert que le recyclage de l'huile usée peut présenter de nombreux avantages du point de vue économique. A peu près 22% d'huile pour locomotives diésels est composé d'huile lubrifiante recyclée. A l'usine Hilton de STELCO, l'huile recyclée est mélangée à l'huile no 6 et utilisée dans les fours à préchauffage des bandes.

Il n'en est pas de même dans le cas de deux gros usagers à l'échelle nationale, qui sont contrôlés par le gouvernement fédéral. La société de chemin de fer Canadien National vient à peine de commencer à recycler une partie de son huile usée, et le ministère de la Défense n'a pas encore pris de mesure lui permettant de régénérer son huile usée.

Ce qui est encore plus grave, le régime fiscal fédéral actuel décourage la généralisation de ce procédé en imposant une taxe sur l'huile régénérée, à laquelle on a mélangé des additifs, et qui est vendue à un autre usager. En Allemagne et en Italie, par contre, le gouvernement accorde des remises aux sociétés qui traitent et régénérent l'huile usée.

L'étude de la législation actuelle comprise dans le présent rapport n'est pas exhaustive; néanmoins, elle révèle de nombreuses lacunes à tous les niveaux de gouvernement, en ce qui concerne la récupération, l'emmagasinage, la manutention et les usages finaux de l'huile usée, et tout particulièrement l'application d'huile sur les routes. L'instauration d'un système efficace nécessitera sûrement l'élaboration de règlements uniformes et détaillés, à l'échelle nationale.

Le problème que pose l'huile usée n'est pas nouveau. C'est la rançon du progrès. A l'heure actuelle, il a atteint de telles proportions que nous ne pouvons plus le négliger. Comme dans la plupart des domaines de la technique moderne, à un progrès réalisé correspond un problème nouveau.

Ainsi, pour pouvoir profiter de l'efficacité, de la viscosité et de la lonque durée des huiles modernes, il faut faire face à la formation de sous-produits et de résidus dangereux. De plus, dans une période où des ressources naturelles qui nous semblaient illimitées s'épuisent et de raréfient, l'huile usée constitue une ressource irremplaçable qu'on est en train de gaspiller. Pis encore, ce gaspillage empoisonne notre environnement et chacun de nous doit s'en préoccuper.

Recommandations

Les recommandations suivantes sont le fruit des constatations de cette études et sont destinées à servir de base à la création de solutions concrètes au problème de l'huile lubrifiante usée. Pour plus de détails à ce sujet, consulter les sections et les sous-sections de ce rapport.

1) Des études sur l'huile usée devraient être menées dans chaque province en vue de déterminer:

   a) les volumes des différentes huiles disponibles,
   b) les systèmes de récupération existants et requis,
   c) les méthodes d'élimination, de recyclage ou les usages finals,
   d) les lois et les règlements nécessaires au contrôle et à l'acheminement de l'huile usée vers le système de récupération correspondant à un usage final ou à l'élimination définitive.

   Les travaux énumérés ci-dessus devraient être effectués par les autorités environnementales en collaboration avec les associations provinciales des sociétés pétrolières et les autres industries ou associations engagées dans la récupération de l'huile usée, les usages finals ou l'élimination définitive.

2) Il faudrait s'efforcer de trouver d'autres moyens de retenir la poussière sur les routes non pavées. Pour commencer, l'huile non traitée ne devrait plus être déversée sur les routes. Quant aux huiles utilisées en attendant, et qui ont été traitées afin d'en extraire le métal lourd, les composants à point d'éclair peu élevé et l'eau ne devraient y être incorporés que par des personnes autorisées, bien au fait de:

   a) la qualité de l'huile à utiliser,
   b) la quantité de cette dernière,
   c) la méthode d'application.

3) Le brûlage à des fins de destruction thermique devrait être le dernier moyen envisagé et ne devrait être employé que lorsqu'il existe des installations de dépollution de l'air suffisantes. Il faudrait plutôt viser une utilisation pratique de l'huile, par recyclage, récupération de la chaleur ou toute autre méthode.

4) Des réservoirs de dimensions suffisantes destinés à recueillir et à séparer l'huile devraient être installés à tous les endroits qui constituent des sources d'huile de lubrification usée, tels les stations-service, les gares de triage, les garages d'autobus et de camions, les stations de production et de transformation d'énergie électrique, les entrepôts maritimes, les aéroports, les usines, les gros postes de réfrigération ou de conditionnement de l'air, les bases militaires, etc. Il faut que soit pratiquée à ces endroits, la séparation des huiles qui constitue la première étape à tout processus d'élimination.

5) Les endroits où l'utilisation de l'huile est moins considérable, devrait emmagasiner l'huile usée dans des contenants approuvés (en se basant par exemple, sur les normes fixées par la loi de l'Ontario sur la manutention de l'essence, Ontario Gasoline Handling Act).

6) Il devrait également exister à ces endroits (voir 4 et 5), des appareils destinés à intercepter la poussière, l'eau et l'huile dans les décharges liquides que celles-ci soient dirigées ou non vers les égouts municipaux. En attendant leur installation, la quantité d'huile contenue dans les décharges liquides dirigées vers les égouts municipaux ne devrait pas dépasser 50 - 100 ppm. Si le déversement est effectué dans un égout pluvial, il faudrait prévoir son raccordement à un égout municipal.

7) L'huile usée recyclée en carburant devrait être traitée auparavant pour en déloger les impuretés de nature métallique avant de la mélanger à d'autres carburants ou de la faire brûler, en utilisant une méthode de combustion qui ne provoque pas de pollution. Un important polluant de l'eau en puissance ne devrait pas devenir un polluant atmosphérique sous prétexte que "la dilution est la solution".

8) Tous les points de vente au détail de l'huile lubrifiante devraient fournir, soit des contenants pour retourner l'huile usée, soit, sur place, une station de récupération de l'huile usée, pour leurs clients.

9) Les organismes et les ministères des gouvernements provinciaux, municipaux et fédéral devraient entreprendre un inventaire de leurs achats d'huile de lubrification et de leurs méthodes d'élimination. Ils devraient passer en revue les possibilités de recyclage et de

régénération des huiles usées en indiquant les propriétés des produits désirés (par exemple, les sociétés hydro-électriques et les services municipaux pourraient régénérer l'huile pour transformateur en indiquant le pouvoir diélectrique spécifique, la tension d'interface, l'indice de neutralisation désirés dans le nouveau produit etc.).

10) Le gouvernement pourrait accorder son aide (financière, technique, légale) pour permettre l'installation de systèmes de récupération visant à des utilisations finales ou à l'élimination définitive (par exemple, en rétablissant la taxe de vente fédérale sur les huiles régénérées comme en 1967 ou même en accordant des remises, comme en Allemagne).

3. THE MAGNITUDE OF THE WASTE OIL PROBLEM

The problem of waste lubricating oil is one that extends over many areas and involves tremendous volumes. If all lubricating oil were used in one place or discharged in one form, the problem would be fairly easy to solve. As it is, oil is used in nearly every sector of the economy, for many purposes in all sorts of machinery from lawnmowers to locomotives, and is then released at thousands of individual sites that may have no facilities for recovery. Furthermore, in its "waste" form, the oil carries a variety of contaminants that could make recycling or alternate use very difficult.

The following sections provide a breakdown of oil sold in specific categories, the volumes of oil that might be recovered and the general quality of "waste oil".

3.1 Volume of Lubricating Oil Sales

Approximately 188 million gallons of lubricating oils were sold in Canada in 1972 (the volume has grown over the years and is still growing - see Graph 1 in Appendix).

The commercial and industrial breakdown is as follows:

Distribution	Imp. Gallons (millions)	% by Volume
Service Stations	46.3	24.6
Farms	14.2	7.5
Fed. and Prov. Govts.	3.4	1.8
Construction	7.8	4.1
Forest Prod. and Paper	9.5	5.0
Mining, Smelting and Petroleum	10.3	5.5
Railways	9.9	5.2
Marine	4.5	2.4
Transportation, Communications and Utilities	79.1	42.1
Misc.	3.3	1.8
Total	188.3	100

This total can be further broken down into the following main use categories:

Application	Imp. Gallons (millions)	% by Volume
Automotive (passenger cars and other on-road vehicles)	73	38.9
Railways (locomotive 7) (other 3)	10	5.3
Marine	4	2.1
Farm	16	8.5
Industrial and Other	85	45.2
Total	188	100

In terms of per capita consumption based on 1972 population, the total represents 8.5 gal/person and the automotive section 3.3 gal/person per year in Canada.

3.2 Volume of Recoverable Lubricating Oil

Of the 188 million gallons of lubricating oils sold, a careful analysis based on existing studies indicates that up to 79 million gallons, or 42% of the total could be recovered.

The following sections describe the situation for major use areas.

3.2.1 Automotive

In addition to regular service station sales, a large volume of oil is supplied by non-service outlets. Studies of the automotive sector suggest that for both service and non-service outlets, up to 41 million gallons a year could be recovered, a figure representing 55% of total lubricating oil sales. This figure is based on the following analysis:

Service Station Sales: A study (3) by A.D. Little for the Commonwealth of Massachusetts in 1960 broke down total service station sales into the following:

a) Sales for oil changes: 70% (90% recoverable as used oil);
b) Sales from topping up oil levels: 30% (non-recoverable at service stations).

Recoverable used oil: .70 x .90 = 63% of total sales

Non-Service Station Sales: A report in National Petroleum News estimated that in the United States between 25% and 40% of all automotive oil sales are in non-service outlets (discount stores, supermarkets, etc.) (2). Some of this oil is recoverable and some of this is not (VIZ):

a) do-it-yourself oil changes: used oil available.

b) topping of oil consuming engines: no used oil available.

c) other internal combustion engines (lawnmowers, outboards, chain saws, etc.): very little available oil.

Almost all of the recoverable oil must therefore come from the automotive do-it-yourself customers of non-service outlets. Since at present such outlets offer neither the facilities nor the incentive for used oil return, the disposal of waste oil is left to the convenience of the users and is lost to the recovery process. It is estimated that up to 40% of such oil sales are available as used oil.

Recoverable used oil: 40% of do-it-yourself oil changes.

If the foregoing percentages were applied to Canada, the situation for automotive oils would be:

Distribution	Sales Imp. Gallons (millions)	% Recovery	Used Oil Imp. Gallons (millions)
Service Stations	53	63	33
Non-service Outlets	20	40	8
Total	73	56	41

The 41 million gallons of recoverable used oil represents 56% of total sales, a figure that compares favourably with the results of a recent study prepared by the Environmental Protection Agency (EPA) in the United States (49). This showed a 56.5% overall recovery rate using eight different sub-categories of automotive lubricating oil sales.

Reinforcing this figure is a Western European study which arrived at a 55% recovery rate for used crankcase oil. Applied to Canada, the percentage represents 40 million gallons a year.

In view of the preceding and other studies (see Attachment No. 20), an overall recovery factor of 55% is therefore considered to be reasonable.

3.2.2 Railways

Locomotives are major users of lubricating oil in the railway area. The major factors governing oil recovery rates for a locomotive are the following:

Oil pan capacity	180 gal
Consumption (average)	40 gal /month/engine
Drain interval (GM loco.)	12 months

Oil recovery calculation: 80% of oil in pan at time of change

$$\text{Percentage of total} \quad \frac{180 \times 80}{180 + 40 \times 12} = 22\%$$

For the non-locomotive crank case oils, the automotive recovery percentage can be applied: 55%.

On the basis of the foregoing recovery percentages, the recoverable oil from railways would be:

Application	Consumption Imp. Gallons (millions)	% Recovery	Recoverable Oil Imp. Gallons (millions)
Locomotive	7	22	1.4
Non-Locomotive	3	55	1.6
Total	10	30	3

In the railway sector, therefore, a percentage of 30% or 3 million gallons of lubricating oil should be available for recovery.

3.2.3 Marine

Since marine engines are similar in design and lubrication requirements to locomotive engines, the locomotive recovery rate can be applied:

Application	Consumption Imp. Gallons (millions)	% Recovery	Recoverable Oil Imp. Gallons (millions)
Marine	4	22	1

One million gallons of lubricating oil should therefore be available from marine engines.

3.2.4 Farm

Farm lubricating oil usage closely approximates that governing the automotive area and therefore the automotive rate of recovery can be applied:

Application	Consumption Imp. Gallons (millions)	% Recovery	Recoverable Oil Imp. Gallons (millions)
Farm	16	55	9

On this basis, nine million gallons should be available from the farm sector.

3.2.5 Industrial and other

Analyses conducted in both Canada and the United States indicate that 30% is a reasonable recovery factor to be applied to industrial users of lubricating oil.

Application	Consumption Imp. Gallons (millions)	% Recovery	Recoverable Oil Imp. Gallons (millions)
Industrial and Other	85	30	26

The recoverable volume from industrial and other sources could therefore be estimated at 26 million gallons.

3.2.6 Overall balance

On the basis of the foregoing, the total recoverable volume of oil in Canada, based on 1972 figures, is as follows:

Application	Consumption Imp. Gallons (millions)	% Recovery	Recoverable Oil Imp. Gallons (millions)
Automotive	73	55	40
Railways	10	30	3
Marine	4	22	1
Farm	16	55	9
Industrial and Other	85	30	26
Total	188	42	79

The recoverable volume amounts to 3.6 gal /person/year and represents 42% of total sales.

Studies in the United States conducted by the E.P.A. have estimated that 50% of total lubricating oil sales is available as waste oil (8). A Western European study showed a "used oil factor" ranging from 48% to 62% depending on the country and a continent-wide average of 53% (48).

The estimated overall recoverable factor of 42% advanced in this report may therefore be low. Certainly the oil use lumped together in the general category 'Industrial and Other' needs to be better analyzed. In addition, more specific information is needed regarding recoverable used oil from farms. Sometimes used oil is employed on farms for miscellaneous secondary lubrication, dust control and fuel.

It is also important to recognize the significant differences that exist between the rural (mechanized, low population density) and urban (industrial, high population density) situations. A study done for Moncton N.B. in 1971 showed recoverable volumes of 4.3 gal /person/ year because the total included the oil from the yards and shops of a major railway. Returns from urban areas will therefore probably significantly exceed the national average.

Graphs showing Canadian lubricating oil sales (10), population (11), number of automobiles registered 1966-72 (11, 59) and oil consumption and drain interval trends are appended.

3.2.7 Volumes of lubricating oils actually recovered

Although re-refining plants are currently treating five to six million gallons a year of waste oil, their activities cannot give any clear idea of the total picture. Very little is known in specific terms of the volumes and location of waste oil sources in Canada and further studies are urgently needed to define precisely the existing situation. Such studies could be the basis of a rationalized and effective waste oil recovery system.

3.3 The Quality of Used Lubricating Oil

There is no consistent description that fits all lubricating oils even in their non-used state. In addition to their petroleum oil

contents and the additives (sodium, barium, calcium zinc and magnesium are frequently added as compounds to impart specific properties to oil (see Attachment No. 17), they may contain vegetable and/or animal fats. Some industrial lubricating oils are formulated as emulsions of either oil in water or water in oil. A wide range of lubricating oils, each designed for a specific purpose, is therefore the basis from which "waste oil" is derived.

The contaminants in waste oil can also vary widely. These can be categorized as volatile (water, gasoline, solvents, fuels and other diluents), soluble (original additives; material acquired during use) and solids (metal fines, dirt, tars, carbon, etc.).

During use the oil will pick up metallic fines from machine or engine wear, combustion and/or corrosion. Such metallic particles can be composed of aluminum, copper, iron, lead, silicon and tin.

The majority of contaminants in crankcase oil, however, result from non-segregated storage and handling of the used oils. All too often, one tank is used to receive and store all liquid wastes, including solvents, used and/or contaminated fuels, used oil and wash water. Likewise, the vacuum trucks that collect the oil also pick up septic tank residue, waste chemicals, tank bottoms and other wastes that inevitably get mixed in with the used oil.

Because of these factors, there is no "fixed" or "typical" breakdown of values that can describe with any precision the composition of waste oil. However, Attachments 1A, 1B, 1C and 1D describe the oil composition and metallic content revealed in some of the studies done on used automotive crankcase oils.

4. WASTE OIL STORAGE AND COLLECTION

As the preceding section suggests, heavy contamination of used oil results from poor handling and storage systems. The following examines present methods of collection and storage in the various main-user categories:

4.1 General

Road oiling companies perform most of the collection of used oil in Canada. Generally these firms give free pick-up of waste oil from bulk storage tanks and charge for the pick-up of drums and quantities of less than 200 gallons. The pick-up charges vary from $5.00 to $15.00 for pumping out tanks and from $2.00 to $6.00 for the pick-up of each drum.

In most urban areas, road oilers have established pick-up routes which they service regularly, usually on a no charge basis. For example, one road oiler's route allows for a six-week interval between pump-outs for a particular group of service stations all of which have storage tanks. The average collection from these is 300 gallons per pick-up.

The average service station supplies about 1000 gallons per year, varying from 50 to 100 gallons per month (16). A 1973 survey of 50 service stations in the Halifax/Dartmouth area averaged 1250 gallons per year (47). In a metropolitan area, one vacuum tank truck can service about 700 service stations on a year round basis (43).

The economic radius of pick-up varies depending on whether free service or fees are involved and the quantity of oils on the particular route. Usually the economic radius is 100-150 miles from the storage facilities. Collection costs vary from 3¢ to 8¢ per gallon (depending upon the size of pick-up and distance) and bulk storage rental costs are from 1¢ to 3¢ per gallon.

To collect waste oil in the whole province of Ontario, a road oil firm in Toronto (43) feels the following would be needed:

Area	Number of Trucks	Storage Facilities
Toronto	5	Yes
Breslau	4	Yes
Sudbury/North Bay	1 (3M gal cap)	Yes
Lakehead	3 (3M gal cap)	Yes
Kingston-Cornwall-Ottawa	1 (3M gal cap)	Yes

In addition, two large tractor trailers would be required to transport the oil from the above storage areas to a central processing site. This also assumes that all service stations, garages, etc., have waste oil storage tank facilities of at least 500 gallons, preferably 1,000 gallons. They would have to be located outside and below ground (to allow for pour point and freezing of water during winter conditions) with proper unloading and venting facilities. (See Existing Legislation section for regulations in Quebec.)

In like manner, the Province of Quebec could possibly be divided into the following regions for a collection system:

1) Saguenay/Lac St. Jean
2) Abitibi/Rouyn Noranda
3) Montréal
4) Québec
5) Trois Rivières-Shawinigan
6) Eastern Townships
7) Lower St. Lawrence
8) Ottawa-Hull

The number of vehicles and storage facilities in each area remain to be determined.

The Province of British Columbia is also being examined in a similar way. An initial review suggested the following:

1) Two to three collection and storage areas on Vancouver Island.
2) One storage and collection system for Vancouver and the lower mainland area.
3) Four to six collection and storage areas for the remainder of the province.

Such a province wide collection system in British Columbia must take into account the mountain terrain and the location of large pulp and paper and logging and mining operations in remote areas. It may be more economic to ship oil from the eastern part of this province to existing re-refineries in Alberta.

In the case of companies that specialize in the re-refining of oil, most have pick-up trucks for waste oil collection and some have rail sidings for receiving bulk quantities. One re-refining company relies on deliveries from two road oiling companies which in turn rent storage from the former.

4.2 Automotive

The major oil companies encourage the use of underground storage tanks (generally 500 - 1,000 gallons capacity) for used crankcase oils. This requirement does not extend to independently owned garages and service stations which do not always have such facilities. Regulations in British Columbia under the Fire Marshal Act require service stations to collect used crankcase oil in 50 gallon steel drums. There are also regulations in Ontario and Quebec regarding waste oil storage and collection (see Existing Legislation section).

4.3 Railways

Canadian Pacific Railways has a collection system for diesel crankcase oil which allows it to recover 22% of its annual consumption in the form of re-refined oil. (This varies from 5% in the Eastern and Prairie Regions, to 20% in the Pacific Region, to 65% in the Atlantic Region.) The oil is collected at seven sites across Canada where it is kept segregated from other waste oils and is then re-refined in Montreal (Atlantic and Eastern Regions) and in Edmonton (Prairie on Pacific Regions) in tank-car quantities (41).

The Canadian National Railways has only recently begun to re-refine its locomotive crankcase oil and up to this time has disposed of it in other ways. In 1973 the company shipped from its Atlantic Region twenty-five tank cars (200,000 gallons) of used and contaminated oil to road oilers and sent three tank cars of oil (24,000 gallons) to an oil refinery in Nova Scotia where it was blended with No. 6 fuel

oil (42). Some contaminated oil was also shipped to Toronto to be blended into No. 6 fuel oil. Some of this contaminated oil contained a mixture of organics (fuels, solvents, oils, etc. and could not be re-refined). (See Fuel Use section for discussion of heavy metal emission).

In recognition of the need for better use of waste oil, the five Regional Environmental Protection Officers of the Canadian National Railways are currently conducting a survey to determine the quantities and types of oils and the existing storage practices in their respective regions. They are also considering segregated storage facilities for waste oils with a view to having oil re-refined to their specifications (see Attachment No. 16).

4.4 Industry

Without a careful and detailed survey it is impossible to give any precise indication of Canada-wide practices in the industrial and public utility segments of the economy. One example of what is being done in the industrial area can be seen in the STELCO Hilton plant in Hamilton, Ontario. Here a PORI process unit was installed in 1971 to remove oil from the plant effluent. It is now being utilized to treat oil/water mixtures from all the STELCO plants in the immediate area. Originally intended to handle rolling oils from the cold mill, it is currently treating hydraulic oils, crankcase and other lubricating oils from the diesel and locomotive shops, coke oven wastes, cutting oils, machine oils and liquid fraction of tank bottoms after cleaning No. 6 and other oil storage tanks. The recovered oil is blended with No. 6 fuel oil and used in the hot strip preheating furnace (26).

The material is collected in a 250,000 gallon heated storage tank to minimize fluctuation in the feed composition. In handling a wide variety of waste materials without segregation, however, problems arise and the varying composition of the feed periodically upsets the recovery process.

In the PORI unit the minimum economic flow is about 500 gpm of oil/water mixture with a minimum oil content of 200 - 600 ppm. At this level, the equipment is claimed to be more economic than a con-

ventional API separator. (Effluent discharge water design specifications are 10 ppm for oil and 15 ppm for suspended solids.)

4.5 Civic

Much remains to be discovered about the role cities and municipalities can play in solving the problem of waste oil. Civic interest has, however, been aroused. In Manitoba representatives of the city of Winnipeg and the province have set up a waste oil committee. It is reviewing all aspects of the situation from collection to disposal and/or end uses of the waste oil generated in the various regions of the province.

In Newfoundland, the city of Corner Brook collects waste oil from local service stations for the purpose of road oiling.

The oil industry itself has recognized the extreme importance of a wide spectrum of involvement from industrial to legislative action to meet the problem of waste oil effectively. A 1973 paper Fuels and the Environment (58) makes the following statement:

The oil industry believes that:

1) Legislation on control of waste oil disposal is desireable.

2) Collection of waste lubricating oil might logically be the responsibility of the local authority in the first instance, as for other refuse. If private contractors are employed to collect waste oil, they should be eligible for a local or national government subsidy, provided the ultimate fate of the waste oil in the contractor's hands is above reproach.

3) To facilitate collection of waste oil, service stations and industrial outlets should provide sufficient storage for discarded oil until it is collected in convenient lots. Ideally this should be underground in order to avoid spillage which may occur in transferring the oil from the sump to the above-ground container or from the container to the disposal vehicle. It is appreciated that cost and local regulations may in some cases make underground storage impracticable.

4) After collection, if re-refining remains undesirable, used oil

should be burned to produce heat or power, or at least without causing air pollution. This step, too, might be undertaken by municipal refuse disposal organizations.

5) Oil companies should be willing and able to give guidance to all users on methods of collection waste oil in convenient lots for pick up, also advise on disposal methods to municipal authorities.

4.6 Conclusion

Even on the basis of the incomplete evidence gathered in this survey, it is clear than an adequate oil collection and storage system must meet the following requirements:

a) Adequate Storage Facilities at the Source of the Used Oil; (service stations, garages, Department of National Defence bases, public utilities, etc.)

These facilities should take into consideration the winter conditions in Canada (underground tanks) and be designed in agreement with gasoline safety handling procedures (see Existing Legislation section of this report). They should be adequately sized (500 - 1,000 gal) to ensure economic pick-up at pre-scheduled intervals.

b) Licensed Tank Truck Collectors and Transporters:
All private collectors should be licensed for used oil collection only or have separate equipment for this material. The latter will provide for segregation from sewage and other used liquids (organic chemicals, solvents, etc.).

These collectors should keep inventory sheets showing how much oil is collected, from whom it is collected, what type of oil is collected and where the particular lot was unloaded. Such sheets should be sent to the regulatory authorities on a periodic basis (monthly or quarterly reports).

c) Local Storage Facilities:
For locations more than 100 - 150 miles from the final disposal site, intermediate or local storage facilities may be needed.

Such facilities should include tankage for re-refinable and fuel type (ultimate end use) storage. A network of these should be interconnected by tank truck or tank car shipping routes.

d) Storage Facilities at final disposal sites:
Whether it be a re-refinery, a cement plant or other installation, a large (250,000 to 500,000 gal) tank must be installed to receive shipments directly from collectors or from the local facilities. This large tank would act as an integrator to reduce swings in oil quality resulting from variations in loads.

It is evident also that most of Canada is not serviced by properly regulated and controlled collection systems. To meet the need, a comprehensive system should be established comprising the foregoing recommendations and allowing no exceptions from authorized facilities. To accomplish this, existing legislation should be reviewed and new legislation introduced. Such action would ensure that used oil is properly collected and channelled through to the desired end-use or ultimate disposal.

5. PRESENT END USES

If current methods of collection and storage of waste oil can be shown to be inadequate and largely unregulated, more serious factors arise in the consideration of most of the existing end uses of waste oil.

Although most present methods can be described as wasteful and ineffective, these are minor charges compared with the major shortcoming: health and environmental hazards. The following sections examine the situation that applies in each of the major categories and provides specific data relating to the nature and effects of the waste oil disposal techniques.

5.1 Road Oiling

Most used oil is picked up by waste oil and/or septic tank collectors and used for road oiling. To date this appears to be the most economically attractive use since municipalities will pay 12 - 20¢ a gallon for oil laid on the road. However, a study by the E.P.A. (12) on one particular road found that:

a) 70 - 75% leaves the road by dust transportation and run-off;
b) 25 - 30% is lost by volatilization, adhesion to vehicles and biodegradation;
c) 1% stays on the road.

This study also showed that the vegetation in the adjacent fields was high in metallic compounds that came from the used oil. (Attachment No. 1 shows analysis of typical automotive waste oil).

Used lubricating oils contain both portions of the original additives and impurities acquired during use and collection. The additive packages include detergents, dispersants and emulsifiers (see Attachment No. 17). The function of these is to form water-oil emulsions and suspensions of solids. These are undesirable properties for road surfacing or dust control and could account for the small proportion of the oil that remains on the road. Also, since there are no rigid specifications for road oil, in some cases other materials are also included in and added to such waste oils. The quantity deposited in road oiling varies from 0.2 to 0.5 gal / yd^2. Most non-surfaced roads receive 1 - 4 applications per year (14).

The Environmental Protection Services of the Province of Quebec were asked to review road oil specification for the Quebec Ministry of Transport. The following specifications are used by them:

Viscosity at 60°C (centistoke)	20 min.	60 max.
Flashpoint	150°F min.	
Percentage Residue (non-volatile)	55% min.	
Percentage water	3% max.	

This is a very broad and loose specification which could allow significant quantities of deleterious materials to be contained in the oil.

In Quebec, the road oilers refer to the above as No. 1 road oil (for provincial government use only). However, the municipalities and towns, who are the major users, do not have a specification and take what they get. The total volume of oil used for road oiling in Quebec is about five million gallons a year (15).

The Ministry of Transportion and Communications of Ontario completed a road oil survey in 1970 (14). Specifications were not, however, adopted as there was concern that publishing such requirements would in effect be condoning road oiling while being cognizant of its possibly detrimental environmental effects. In 1973, about seven million gallons (16) were used on Ontario roads as dust palliative.

In June 1971, some cattle in Alberta were poisoned by drinking water containing lubricating oil (triaryl phosphate) from a natural gas compressor station (13). Triaryl phosphate (a fire resistant phosphate ester) is used as a hydraulic oil in aircraft. This incident prompted the Department of National Defence to stop road oilers picking up POL (Petroleum Oil Lubricant) waste from their bases. The 53 bases in Canada produce about 40,000 gallons a month of liquid organic waste (46).

In an effort to gain further information on a possibly hazardous activity, the Roads and Transportation Association of Canada (RTAC) has agreed to work with Environment Canada and will send a questionnaire out to its members to determine the present status of road oiling in Canada.

To remove possibly dangerous contaminants, road oil would have to be treated before application. The following is a typical cost comparison of treated and untreated oil:

	Without Treatment (¢/gal)	With Treatment (¢/gal)
Cost of Oil Collection	4-5	4-5
Storage costs	0-1 1/2	0-1 1/2
Treatment costs	0	5-12
Spraying costs	3-4	3-4
Total	7-10 1/2	12-22 1/2
Selling price	12-20	12-20
Gross profit	1 1/2-13	0-8

Treatment would consist of thermal dehydration (up to 600-625^{o}F) and stripping (removal of low flash point material and water) followed by sulphuric acid contacting (3-4% $H_2 SO_4$ to precipitate heavy metals) and neutralization with caustic. Other processes may also be used to remove such impurities.

In a different road application of waste oil, a Vancouver firm is combining a 50-50 mixture of used oil and medium cured asphalt with coarse aggregate to produce an inexpensive road topping (19).

The use of waste oil as a dust palliative is in several respects an unsatisfactory disposal method. Not only does it represent the loss of a non-renewable natural resource which could be recycled, but also, by its composition and nature, it cannot effectively perform the desired function. Furthermore, most of the oil and its contaminants (heavy metals, organic polynuclear aromatics, etc.) are put into the environment.

In the interim, and until a satisfactory solution is found, it is desirable that the use of oils as a dust palliative be conducted only by licensed collectors who are regulated with respect to:

a) quality of the oil to be used,

b) quantity of oil to be used, and

c) method of application.

All of the above can reduce the polluting effects of waste oil on roads.

5.2 Fuel Use

Another use of waste lubricating oils is in the form of fuel. This might seem to be a natural, simple and economic disposal process. Unfortunately, however, as in the use of waste oil on roads, the pollution hazards are considerable. The emission of non-combustible compounds in the oil make the fuel-use method of disposal one to be used with discretion.

5.2.1. Heat value

Used lubricating oil with a 10-14% BS&W (bottom sediment and water) has a heat value of 120-140 MBTU/gal (17). Studies in the United States showed average results of 120 MBTU/gal with 0.6 to 18% v/v BS&W (5, 20). Tests done in Toronto found 139 MBTU/gal at 8% water content (16). The heat value of used lubricating oil is therefore about 30-40 MBTU/gal less than No. 6 fuel oil (No. 6 has about 183 MBTU/gal). (See Attachment No. 2 for relative heat value of different fossil fuels.) The heat value varies with the BS&W of the waste oil (See Attachment No. 3). Base stock lubricating oils have an API gravity of 25 and therefore a heat value of about 174 MBTU/gal.

Used lubricating oil has a low sulphur content (See Attachments 1D and 4) and has a lower viscosity (See Attachment No. 5) than bunker fuels (18, 50). Blended mixtures of waste oil and bunker fuel would therefore be easy to handle and burn. (Atomization and ease of pumping are functions of viscosity). The viscosity will also be a function of BS&W and dilution by low boiling point material. (Flash point is a measure of low boilers; See Attachment No. 6.)

An initial report by the American Petroleum Institute (API) suggested blending up to 25% waste oil into No. 6 fuel oil (20). Because of possible deposits in the boiler tubes and fire box, wear on the burner, and air emissions, however, follow-up reports suggested blends of up to 1-2% (4, 21).

5.2.2 Metallic content and emissions

Work done by Walter C. McCrone Associates based on oil samples taken in the late 1960's, (see Attachment No. 7) showed an average of 1,140 lb of metallic oxides formed in the burning of 10,000 U.S. gallons of waste automotive crankcase oils. This figure was based on nine samples taken across the United States. The study found that the oil had an average lead content of 0.68% w/w with a range of 0.46 to 0.82% w/w.

On the basis of the above, the burning of all waste automotive crankcase oils in Canada would result in the following yearly emissions:

$$\text{Metallic Oxides} = \frac{41 \times 10^6 \times 1140}{10{,}000 \times 0.834} = 5.6 \text{ million lb /yr}$$

According to the McCrone Study, the oxides of lead, phosphorus and calcium were 52%, 18.6% and 14.3%, respectively, of the total. Oxides of zinc, copper, aluminum, barium, nickel, chromium, iron, silicon, tin, boron and magnesium accounted for the remaining 15%.

A 1973 used oil survey (51) conducted for the API (see Attachment No. 1c) gave the following lead content as compared to the McCrone data:

Source of Waste Oil	Lead Content Weight Percent			
	Min.	Ave.	Max.	Lead/Ash % w/w
Service Stations	0.56	1.37	2.17	40
Truck Fleets	neg.	0.07	0.54	8
Taxi Fleets	0.46	0.96	2.08	36
Off-road Fleets	neg.	0.17	0.92	16
Zone Composite (see reference)	0.51	0.82	1.20	37
Collection Service	0.14	0.44	0.87	46
McCrone Associates	0.46	0.68	0.82	52

This summary of the API survey shows that the lead levels of waste oil depend upon the fuel used. Off-road fleets and truck fleets are powered primarily by diesel engines and diesel fuel does not contain organic lead anti-knock compounds (tetraethyl lead: TEL; tetramethyl

lead: TML). The lead content of gasoline engine crankcase oil reflects the use of such additives in gasoline (premium gasoline contains 2.95 g/gal , regular 2.35, averaging 2.54 g/gal). The report also shows that the ratio of lead/ash remains fairly constant, 36% w/w to 40% w/w, for oil from service stations, taxi fleets and zone composite.

The API data indicate a significant increase in the lead content from service stations compared with the results of the McCrone study (1.37 versus 0.68% w/w). The decrease of the lead/ash ratio (52 to 40) indicates an overall increase of additives and other inert substances in the waste oil.

On the basis of 1.37% w/w Pb (lead) in waste automotive oil, and 40% w/w lead-based ash, the lead oxide emission from the burning of the 41 million gallons of used automotive lubricating oil in Canada would be:

$$\text{Lead Oxide Emission: } 41 \times 10^6 \times 9 \frac{(\text{lb})}{(\text{gal})} \times 0.0137 \text{ (\%w/w Pb)} \times \frac{223}{207} \frac{(\text{PbO})}{(\text{Pb})} = 5.4 \text{ million lb /yr}$$

$$\text{Total Metallic Oxides} = 5.4 \times \frac{207}{223} \times \frac{1}{.4} = 12.6 \text{ million lb/yr}$$

as compared with 2.9 million lb/yr using the 0.68% w/w and 52% w/w of the McCrone work. (See Attachment No. 8 for lead content of fuels.)

The difference stems from the changes in oil formulation in the last decade. In the period from the late 1960's to 1973: 1) the mileage interval between oil drains increased (see Graph No. 6 in Appendix); 2) Mileage per gallon of gasoline decreased and; 3) multigrade (high additive content) crankcase oils became more common. These factors contributed to the high lead and other inert content of lubricating oil.

The trend to longer oil drain intervals will undoubtedly continue. Projections of up to 12,000 miles or 12 months are already being made (62) and work is underway to make 18,000 miles the regular drain interval. This will require an increased and improved additive content in crankcase oil. The lower engine compression ratios of today's cars and the effect of air pollution abatement equipment in decreasing

gasoline mileage, will become the rule as pre-1972 cars are phased out. The current requirement of lower lead content in gasoline will help to offset the above factors (the present level ranges from 1.4 to 4.6 g/gal with a 1975 projected maximum of 3.5 g/gal). Nevertheless, the overall trend will be toward increased lead and ash content in used automotive crankcase oils.

The heavy impurity content of crankcase oils presents problems in the use of such oils as fuel. To date, most waste oil burning studies have measured the lead emission during normal burning and have largely neglected the emissions during soot blowing. This is mainly due to lack of adequate sampling methods and equipment for the latter type of emission.

The Shell Oil Company Wood River Refinery Waste oil Burning Test (20) concluded:

> "Effects of fouling were not evident during this test, but this could be observed to a certain extent since about 1/16 inch of powdery and easily removed flake-type deposits were present on the tubes visible in the firebox. Even though stack samples do not account for loss of more than 50% of the lead during normal operations, it must be concluded that much larger amounts leave during soot blowing operations. This is also confirmed by absence of deposits in the boiler except in equilibrium amounts on the tubes." (underlining added.)

Humble Oil and Refinery Company Waste Oil Burning Test at Sewell's Point Terminal showed ground level concentration of less than 0.05 $\mu g/m^3$ during normal operation and 0.67 $\mu g/m^3$ while soot blowing (20). The soot from tubes contained 43%/w lead and was found to be dark grey powder (heavy soot). Again, no excessive deposits accumulated that could not have been removed with more frequent air blowing.

The same section of the report (20) refers to burning by The Snow White Cleaners and Launderers. This firm has burned waste oil for years with the following results:

> "They have found no problems, and deposits accumulated only on

the fire box floor, not on tubes or refractory walls. These deposits are removed manually by brush about every three months. No excessive burner erosion has been experienced. They have experienced no problems in obtaining their requirements for this operation."

Ash content is a measure of the non-combustible solid matter in fuels (see Attachment No. 9). In the case of waste oil it is primarily a measure of ash-forming metallic compounds which are the principal components. Waste oil ash content varies from 0.2 to 6.4% w/w, with an average of 2.3% w/w.

The laundry burned about 3,000 US gallons a month. Using an average waste oil density of 7.6 lb/US gal, the total ash formed in the three months burning period (interval between clean-outs) would be:

Ash formed: $3 \times 10^{3} \times 3 \times 7.6 \times 2.3 \times 10^{-2} = 1{,}570$ lb

This amount was not indicated to have been found in the combustion equipment and therefore had to emitted out the stack during:

a) normal operations
b) soot blowing

Such an operation would not have a high stack. Since there would be very little dispersion, ground level metallic concentrations from stack emissions would therefore be high.

Data from the API waste oil burning test performed at Hawaiian Electric Co. plant in January 1974, showed soot blowing produced flakes up to 3-5 inches in size (49). In the earlier waste oil burning tests at this installation, large amounts of stack deposits were flaked off and sporadically discharged from the stacks, even at full load conditions (56 mw). The analysis of these flakes showed the major components to be iron (36.5% w/w), lead (4.3% w/w), calcium (1.7% w/w), zinc (0.4% w/w) and magnesium (0.3% w/w). During these discharges, the lead emitted from the stack exceeded the lead in fuel fed to the boilers. This indicated emission of the accumulated ash and other material deposits.

A burning test was performed by ESSO Research and Engineering

Company using a small 50 h.p. Cleaver Brookes boiler (52). The fuel feed was 7.5 US gal/hr of 100% waste oil. This study included a measurement of particulate emission and particle size distribution during normal burning:

Particulate Emission During Normal Burning

Metallic Components	wt % of Total Emissions		Size Distribution as wt %		
	Range	Average	< 1 Micron	1-10 Micron	>10 Micron
Pb	14-19	16	76-79	16-21	2.7-4.4
Ca	8-13	10	10-19	71-74	10-15
P	6.1-7.7	6.9	23-42	49-66	8.9-10
Zn	3.7-5.0	4.3	56-73	23-39	3.4-5.0
Fe	0.9-1.3	1.1	2.7-36	51-80	13-18
Ba	1.2-2.6	1.9	3.3-51	40-79	8.9-18

From these data it can be concluded that most of the lead and zinc is emitted in submicron size. These metals are found in waste oil, even after extended settling periods, because of their submicron size and the presence of suspension and emulsifying agents (part of additive package in lubricating oils).

The following data were collected during the normal burning periods at Humble's Baltimore Terminal tests (53) with feed rates of 331 to 475 US gal/hr using blends of waste oil in bunker fuel.

Lead Emissions During Normal Burning

Test	Date	Waste Oil in Bunker Feed %V/v	Lead in Feed to Boiler lb/hr	Lead out The Stack lb/hr	Ration of Lead out / Lead In %W/w	Lead in Particulate Emitted %W/w
1	8-15-72	1.04	0.235	0.104	44.8	2.95
2	8-15-72	1.16	0.235	0.156	66.4	6.04
3	8-18-72	1.04	0.227	0.160	70.5	5.96
4	8-22-72	5.27	1.17	0.504	45.1	14.8
5	8-23-72	5.32	1.17	0.389	33.2	14.7
6	9-06-72	3.83	1.14	0.400	35.1	15.6
7	9-08-72	3.14	0.914	0.424	46.4	14.2
8	9-11-72	3.74	0.933	0.480	51.4	13.3
9	9-13-72	4.30	1.05	0.496	47.2	14.0
16	10-11-72	15.2	3.77	0.806	21.4	23.8
17	10-17-72	12.3	3.11	0.746	24.0	19.1
18	10-18-72	13.8	3.57	0.849	23.8	23.8
19	10-09-72	0	0	0.004	----	0.287

From these data the following conclusions about emissions during normal burning can be drawn:

1) Lead emissions (lb/hr) increase with increased lead content (waste oil content) of the fuel.
2) Lead content (% w/w) of the particulate emissions increases with increased lead content (waste oil content) of the fuel.
3) Ratio of lead out to lead in (% w/w) decreased with increased lead content (waste oil content) of the fuel.

As the percentage of lead in fuel feed increased, the percentage of lead emitted during normal burning decreased, but the total output of lead (lb/hr) increased. Also, as the percentage of waste oil in the feed increased, the amount of ash producing materials increased and the

requirements for soot blowing increased.

The Hawaiian Electric Co. burn used an average of 9.4 lb/hr, (with a range of 1.3 to 26.4 lb/hr) of waste oil in the fuel (49). This represented about 7% v/v of the fuel. Total particulate emissions varied from 18.2 to 135 lb/hr and averaged 51 lb/hr. The lead content average 18.4% w/w of the total particulate emitted during normal burning periods.

That these two tests are in reasonable agreement is shown by the following table:

Burn	Test No.	Waste Oil In Fuel Feed % v/v	Ratio of Lead out Lead in % w/w	Lead In Particulate Emitted % w/w
Baltimore	1-3	1	60.6	5.0
Baltimore	4-9	5	43.1	14.4
Hawaii	-----	7	25-29	18.4
Baltimore	16-18	15	23.1	22.3

The Baltimore report also showed agreement with the original API report (20).

EPA has summarized the results of ten burning trials in the United States (49). (See attachment No. 10.) These studies show that on the average about 50% of the lead fed to a burner is emitted during normal burning periods. Using the results of the ESSO burn (52), it can be concluded that most of this emission is in submicron size.

A burn at Northern States Power Company was fired with 3% waste oil and 97% coal fuel blend (50). The electrostatic precipitation system removed about 98% of the lead generated by the fuel. This system was designed for a coal-fired plant. Such results, however, could not be attained with oil, because of the difference in ash content of coal compared with fuel oil (see Attachment No. 9). Fly ash is believed to act as an absorbent for the metals in the feed.

From the above series of data and discussions, it can be concluded that practically all the lead in the fuel fed to a boiler and/or furnace will be emitted from the stack. About 50% will be emitted

during normal burning periods and the balance during soot blowing.

There is some evidence also that the burning of 100% waste lubricating oil in some boilers causes a metallic complex to be plated out on parts of the boiler (20, 53, 53). This could be due to large surface area, cold spots, firebox and/or burner design; amount of and composition of metals in the feed fuel, flame temperature, etc. (52). The Baltimore Terminal burning test suggests a theoretical explanation for the formation of varying melting point eutectic compounds and therefore depositions while burning 100% waste oil (53).

As the ESSO report pointed out, lead is the most volatile component of the ash forming metals in the waste oil (52). The lead in the ash decreased from 31 to 22 to 2% w/w as the temperature was increased from 1,000 to 1,600 to 2,000^{o} F. The boiler deposits were found mainly in submicron size, as a white layer.

It is evident, however, from the tests, that burning used lubricating oils in commercial and industrial installations can be done for extended periods without the necessity to shut down for clear-out. This suggests that most of the deposited materials are removed during soot blowing.

Further studies should be based on a complete material balance of impurities. More work is necessary to determine if high ash fuels (coal, municipal garbage, etc.) can effectively tie up the metals in the waste oil, in such forms that can be removed by pollution abatement equipment (baghouse, scrubbers, electrostatic precipitators, etc.)

A problem quite apart from metallic emissions, and perhaps even more serious, is that of polynuclear aromatics (PNA's). These are complex hydrocarbons that have been linked to cancer. If they are carcinogenic, as suspected, then any re-use of waste lubricating oil, or its disposal by burning, must ensure that PNA's are not released into the environment in a form that will constitute a hazard. A recent American study found that used lubricating oils contain 25% more PNA's and polar compounds than virgin lubricating oil (4.9% vs 3.9%) (63). The data also show that these compounds can be reduced by treating the waste oils as per the following:

1)	new oil (10 w 30)	3.9%
2)	used oil	4.9%
3)	acid/clay heated used oil	2.4%
4)	butanol/acid treated used oil	1.0%
5)	caustic/distillation treated used oil	3.9%

What levels of PNA can be considered harmless has yet to be determined. It is clear, however, that normal burning procedures cannot destroy them (PNA's need temperatures of 2,600° - 3,000° F, with adequate residence time, to be consumed (64)) and therefore reduction of PNA's to safe levels before combustion will be a necessity.

5.2.3 Cement kiln fuel

Another, very promising, investigation revealed that a cement kiln acts as a natural dry lime scrubber (e.g. greater than 95% of sulphur in fuel is absorbed by the clinker (see Attachment No. 11)).

Corroborating this, a report on the disposal of waste oil in Western Europe by Concawe (48) states:

"Another application for used oil as fuel can be found in the cement industry and in bitumen manufacturing. The production of cement in rotary kilns and the preparation of road making aggregates require a high heat input. Since the raw material absorbs all kinds of fuel components, e.g. sulphur, metals, ash, impurities, etc., the finished products can be considered as a sink for all the materials in the used oil".

This would trap the contaminants in a form that is both non-hazardous and socially useful.

Last year, the St. Lawrence Cement Co. in Mississauga, Ontario, burned 300,000 gallons of used oil in a dry process kiln equipped with a suspension preheater. This kiln has three burners. One was used for waste oil, while the others continued to burn No. 6 fuel oil.

Preliminary data obtained from this burn indicated 80-90% of the lead and zinc was absorbed by the clinker (22). If, however, the lead and zinc in the clinker exceed approximately 0.1%, the setting and hardening properties of the cement are adversely affected. This

limit was not reached in the above mentioned burn.

A proposal has been submitted jointly by St. Lawrence Cement Co. and the Ontario Research Foundation to the Ontario Ministry of the Environment and Environment Canada to burn in excess of one million gallons of used oil and a mixture of used oil and neutralized emulsified acid sludge from a used oil re-refinery. During this test a material balance will be done on lead, zinc and phosphorus. The following elements will be monitored to determine if an emission problem exists: Pb, Zn, P, Br, Cl and F . The St. Lawrence Cement Co. has already installed storage, lines, pumps, etc. ($48,000 capital investment) for handling waste oil as a fuel.

If this burn is successful, a follow-up trial may be proposed to prove the same results in a wet process kiln.

It is interesting to note that cement kilns are located in most population centres in Canada (see Attachment No.12). If it is assumed that the quantity of used oil available at any location is proportional to the population, then the cement kiln could provide local disposal sites. This disposal is practical from the standpoint of economics, conservation of resources, and pollution.

5.2.4 Handling safety

The flash point of a fuel oil (see Attachment No. 6) is an indication of the maximum temperature at which it can be stored and handled without serious fire hazards. The minimum permissible flash point is usually regulated by federal, provincial or municipal laws and is based on accepted practice in handling and use (56).

The flash point of used lubricating oil is a function of dilution with low boiling contaminants (gasoline, solvents, JP4 jet fuel, etc.). Work done by the National Research Council of Canada (see Attachment No. 13) shows the sharp decrease of the flash point of lubricating oil with only 2-3% low boiler dilution (24). Used automotive lubricating oil has been known to contain up to 10% contamination with gasoline or solvents with a normal range of 2-3%, because of handling or segregation practices (5). Therefore no uniform quality can be assured nor the inherent danger recognized.

The organic liquid wastes being collected by the Department of National Defence contain a mixture of lubricating oils, aviation fuels, solvents, cleaning fluids, etc. Since they are not segregated in the collection, they can be used only for fuel in a specially designed high pressure fuel system (about 300-400 psig using specially designed atomization burners). Low flash point (less than 130°F) materials should be collected separately.

A.S.T.M. specifications state:

"Appreciable amounts of water and sediments in a fuel oil tend to cause fouling of the facilities for handling it, and to give trouble in burner mechanisms. Sediment may accumulate in storage tanks and/or filter screens or burner parts, resulting in obstruction to flow of oil from tank to the burner. Water in distillate fuels may cause corrosion of tanks and equipment and it may cause emulsions in residual fuels". (56)

A large re-refinery in the United States analyzes each lot of used lubricating oil received from waste oil collectors (57). It finds the yearly average of BS&W to be 17% w/w (see Attachment No. 3). From the API survey, (see Attachment No. 1C) the water content varied from 0.0 to 16.8% v/v and the sulphated residue from 0.2 to 6.4% w/w.

The quality and properties of waste oil can therefore fluctuate over a wide range of values (50,51) (see Attachment No. 1A, 1B & 1C) with No guarantee of consistency. As previously shown, most of the contaminants are introduced by poor handling practices (lack of segregation of storage, lack of proper storage facilities, etc.).

The following properties are listed in the Canadian Federal Government (54) and Canadian Standards Association (55) specifications for fuel oil:

Fuel Oil Specifications

Fuel Oil No.	Flash Point Minimum. °F.	Water & Sediment Max. % v/v	Carbon Residue on 10% Bottoms Max. %	Ash Max. %w/w
1	110	trace	0.15	-----
2	110	0.05	0.35	-----
4	130	0.50		0.10
5	130	1.00	----	0.10
6	150	2.	----	-----

It can be concluded from the foregoing studies (lead emissions, flash point, ash content, etc.) and the specifications above that untreated used lubricating oil, either as a fuel mixture or by itself should not be used in:

a) domestic burning facilities (homes, schools, etc.)
b) commercial burning facilities (service stations, laundries, etc.)
c) industrial facilities that do not have proper pollution abatement facilities.

The first two are usually unattended burners with low stack heights in high population density areas. The last should only be allowed after authorization from local authorities (after consideration of both environmental factors and safety: fuel handling and burning).

The Canadian Standards Association fuel code (25) states:

"Any fuel composed in whole or in part of crankcase drainings or derivatives thereof, shall not be supplied or used for oil burning appliances unless:

a) the supplier has received approval from the authority administering the code; and
b) the fuel meets all the specification requirements of fuel grade numbers 5 or 6."

It should be noted that fuel grades 2 and 4 (domestic and commercial fuels) were purposely omitted.

"Regulation governing the Approval, Sale, Installation and Maintenance of Oil-burners and Oil-burning Equipment and Appliance Using Inflammable Liquids or Fuel" (Pursuant to the Fire Marshall Act, Province of British Columbia) states in Division 2:05: "No person shall supply for use or use any crankcase oil as oil fuel in any oil-burners".

The Revised Statues of Nebraska, 1971, Chapter 66, Section 66-312.01 state:

> "66-312.01. drain oil: definition: sale or use unlawful: violation: penalty. It shall be unlawful for any person to sell or offer for sale or to use drain oil, or a mixture of drain oil and standard commercial fuels, for heating or power

fuel purposes unless such drain oil has been reprocessed so as to reduce the combined water and solids content to a maximum of one per cent by weight and completely remove highly flammable aromatic hydrocarbons having a flash point of sixty degrees Fahrenheit or less, such as gasolines, toluol, benzol, methyl and ethyl alcohols, acetone, and methyl ethyl ketone.

For the purposes of this section, drain oil shall mean used lubricating oil which has been drained from any internal combusion engine. Any person violating the provisions of this section shall be guilty of a misdemeanor and shall, upon conviction thereof, be punished by a fine of not less than one hundred dollars and not more than one thousand dollars." (underlining added).

The handling of fuel and waste oil in Ontario must comply with the Ontario Gasoline Handling Act, 1969, and the Gasoline Handling Code, as well as regulations made under this Act. In the Province of Quebec, there is a "Petroleum Products Trade Act" and Bill 23, "The Transport Act", dealing with similar regulations. There are also environmental laws, which regulate the collection, storage, transportation and handling of waste materials. (For further details, see the Existing Legislation section of this report).

5.2.5 Treatment

Waste oil can be treated to remove low boilers, water, sludge and other solid matter (both metallic and organic). The treatment can be classified into the following general types:

a) Dehydration and stripping: the removal of water and low boiling point diluents by flash distillation, demulsification and decantation.

b) Sludge or large particulate solids removal: chemical coagulation and/or precipitation, with settling, filtering or centrifuging.

c) Re-refining: this may include some of the above steps followed by further processing such as chemical treatment,

distillation, clay contacting and filtration.

(See Re-refining Section of this report for a more complete discussion).

The GCA Corporation study (50) lists the following treatment processes for removing used lubricating oil impurities for fuel use:

Treatment Process	APPROXIMATE WASTE OIL CONTAMINANT CONCENTRATIONS				
	BS & W % v/v	H_2O % v/v	Ash % v/v	Pb % v/v	Sediment % v/v
No Treatment	10	8	3	1	5
Settling Pretreatment	1	0	2.3	0.0	2.5
Centrifugation	1.5	1	1.5	0.75	1.7
Solvent Extraction	0.3	0	0.3	0.1	0.3
Vacuum Distillation	0	0	0	0	0

The previously cited ESSO report (52) included the following statement, "The results emphasize the necessity of removing the inorganic ash from the waste oil prior to combustion".

This report also investigated two treatments:

1) Dehydration to less than 1% w/w H_2O followed by solvent extraction (solvent/oil volume ratio of 5:1 n-hexane and n-propyl alcohol) and centrifuging,
2) Direct distillation: vacuum distillation at 20 Torr approximately 83 % w/w was distilled prior to a temperature of 702° F.

Distillation was found to be most effective as shown by:

Percentage Lowering of Contaminants

	Ba	Ca	Pb	Fe	Zn	P	S
Distillation	—	< 94	< 88	< 50	< 88	< 90	48
Precipitation	—	63	88	50	50	40	9

It should be remembered that each treating process, in turn, produces treatment wastes (contaminated water, low boiling point and/or non-condensable vapours and gases, sludges, etc.). These also must

be handled in an acceptable, non-polluting manner.

One re-refinery in Canada processes waste lubricating oil using heat, caustic chemical treatment and decantation with flash distillation, if necessary (the removal of low boilers to raise flash point). The recovered oil is blended with No. 2 fuel oil (low ash content) to produce a "No. 4 type" fuel oil. The recovery is about 70% and the total cost of recovering the oil is 9-11¢ per gallon (Nov. 1973 prices). This company produced about one million gallons of this oil in 1973 (15).

At the STELCO Hilton Plant in Hamilton, a "PORI" Process unit was installed in 1971 to remove oil from the plant effluent (see reference in Storage and Collection section). It is now being used to treat oil/water mixtures from all their plants in the immediate area.

The process is a combination of flocculation, flotation, H_2SO_4 contacting and filtering with perlite on a continuous rotary vacuum filter. The recovered oil (heat content 178 MBTU/gal) is blended with No. 6 fuel and used in their hot strip preheating furnace (26).

The cost of treating waste oil will, of course, vary with the process used, the number of purifying stages employed, the cost of collecting and handling the waste oil, and the volume handled.

The following are typical costs for fuel end-uses (based on Nov. 73 data):

	Without Treatment (¢/gal)	With Treatment (¢/gal)
Cost of Collection	2 1/2 - 5	2 1/2 - 5
Storage Cost	0 - 1 1/2	0 - 1 1/2
Treatment Cost	0	5 - 12
Total Cost	2 1/2 - 6 1/2	7 1/2 - 18 1/2

The price of No. 6 fuel oil in Montreal was about 16¢ per gallon (Nov./73), but because of changing oil prices, this is a moving baseline. On an equivalent, BTU basis, the price for used lubricating oil (with BS&W) could be:

$$16 \times \frac{140}{183} = 12 \text{ ¢ per gallon}$$

Regardless of costs, however, it is clear that, if waste oil is to be used as fuel (with the possible exception of use in a cement kiln), pre-use treatment is essential to prevent the emission of toxic substances.

5.3 Thermal Destruction

There are two firms operating in Ontario and Quebec which thermally destroy in excess of 30 million gallons a year of liquid organic wastes. This is usually done for a charge of 8 - 12¢ per gallon.

These firms offer a valuable service in disposing of organic waste chemicals and solvents. However, existing collection systems are very erratic and, as pointed out in the section on storage and collection, segregation is seldom practised by vacuum tank collectors. Therefore these existing facilities are not receiving the quantities of non-recyclable materials that are available.

The thermal destruction plants are looking for high heat value liquids to help support combustion in their units and would welcome petroleum liquids to help meet this need. The combustion usually takes place at about 2,400° F but, even at this high temperature, exhaust gases are a potential source of air pollution, particularly if used automotive crankcase lubricating oils were being burned. Combustion at 3,000° F would, however, remove the threat of PNA pollution (see reference in Fuel Use section).

The disposal of used oil by thermal destruction should be considered only as a last resort since there is no heat recovery (fuel end use) or recycling involved. It may, however, be the answer for some non re-refinable emulsion oils, provided that adequate air pollution abatement facilities were used.

Some proponents of fuel use for waste oil point out that the heat available from the good re-refinable used lubricating oils would be sufficient to supplement the heat needed for the high water content oils, if both were burned together. They also point out that burning is a final disposal.

A paper prepared by the Sun Oil Company on the subject of lubricating oils (60), however, stresses the need to conserve this

important non-renewable natural resource whenever possible. While recognizing the need for the burning of some waste oils, it points out the possible air pollution problems inherent in the process. Whether burning should be accomplished by thermal destruction (no heat recovery) or by fuel use (heat recovery) has to be decided on the basis of the quality of the oil, the cost at the final burning site and the nature of the available air pollution abatement facilities.

The whole question of the thermal destruction of waste oil is therefore one that needs further intensive investigation. Thermal destruction would appear to be an acceptable means of disposing of non-recyclable oil wastes provided that pollution hazards are controlled.

5.4 Re-refining

Re-refining of waste oil is undoubtedly the most attractive means of solving the problem of used lubricating oils. Unfortunately, difficulties ranging from the composition of waste oil to the present tax structure prevent re-refining from being the simple and easy answer that it would otherwise appear to be.

Out of the approximately 80 million gallons of waste oil being generated in Canada each year, only 5 - 6 million are being re-refined.

Changes in the formulation of lubricating oil in recent years have created problems in so far as re-refining is concerned. The need for longer intervals between oil changes (1960 2-3,000 mi.; 1972 6,000 mi.), higher oil pan temperatures (1960 175^{o}F; 1972 300^{o}F) and reduced oil capacity in the engine (1965 4$\frac{1}{2}$ qts.; 1972 3-1/3 qts.) (39) have caused a wide range of more sophisticated additives to be added to lubricating oil in order to meet more exacting operating conditions. Unfortunately, the increased effectiveness of the additives in the oil is matched by the increased difficulty in removing them in the re-refining process.

In addition to complications introduced by the formulation of of lubricating oil, present methods of collection and storage compound the problem. Heavy or residual oils, lubricating oils, light boiling organics and halogenated hydrocarbons (i.e. cleaning and degreasing

fluids) are quite different in their properties and should never be mixed. When they are all lumped together in a tank and labelled "waste oil" they cannot be re-refined.

With effective segregation of waste oils, however, the problem is made much simpler. As Attachment No. 16 shows in the case of railway oils, certain waste oils can be re-refined for specific purposes. Used diesel crankcase oil can be re-refined into car journal oil or back into crankcase oil. Other wastes can be turned into fuel and so on. As in the case of municipal garbage recycling, separation is the first step, and a very important one, in the disposal process.

5.4.1 Present use technology

Re-refining in Canada is presently done by the conventional acid/clay process which usually involves the following:

a) Storage of raw as-received waste oil

1) diesel oil: usually processed separately and returned to the same customer,
2) transformer oil: dried by distillation, filtered and anti-oxidant re-added,
3) automotive and others: stored in a large (250-500,000 gal) tank to minimize fluctuations in plant feed from variations in truck loads.

b) Dehydration/Predistillation.

Diesel oil is heated to about 525-550^{o}F and automotive to 600-625^{o}F. This distils off the light boilers (water, gasoline, solvents, some unsaturated hydrocarbons, etc.) and thermally degrades some of the additives in the oil. The water is removed at 270-300^{o}F. At the end of the distillation a brownish material is observed in the overhead condensate.

The condensed vapours are decanted into oil and water layers. The former can be used for fuel, post oil, "frack" oil, etc. It can also be used to make a blend with the acid sludge from the next step in the process. The volume of this oil layer will depend upon the final

distillation temperature (amount of predistillation). This will vary between 5-15%.

The water layers from this operation need to be treated before being released from the plant as they will contain phenols, oil, acid, etc.). The non-condensables from the distillation step have to be passed through a caustic scrubber to remove air polluting compounds. The total (water plus oil layers) removal in this dehydration step will vary between 5% and 15%.

c) Acid treatment

The percentage of H_2SO_4 will vary from about 4% with good predistillation, to 6-7% with partial distillation. This step is carried out in an agitated cone-bottomed vessel. Air purging (for a short period of time) is usually used to help remove low boilers present. The latter practice requires a caustic scrubber to be used for the off gases.

This step produces an acid sludge amounting to 11-12% of the dried oil feed to contactor with complete predistillation. This material is usually trucked away to land fill sites. The sludge contains metals and other heavy impurities from the used oil (see Attachment No. 14).

The sludge may be able to be blended with the predistillation condensate (about 50/50 mixture) in a mechanically-operated, heated (140-150^{o}F) vessel. This mixture could then be further blended into No. 6 fuel oil for a possible industrial fuel (e.g. cement kiln). (See reference in Fuel Use section).

There is also an indication that the acid sludge could possible be processed and used for asphalt or for manufacturing roofing paper or roofing shingles. A study is also being done in the United States of the use of the sludge for feed to a lead recovery plant (49).

Such end-uses of the sludge will have to be further investigated. One re-refinery in Canada is producing a neutralized emulfified acid sludge which is being blended into non re-refinable waste oils for road oiling.

d) Clay contacting

The decanted oil from the acid contactor is mixed with clay (4 to 5 lb clay/100 lb of acid treated oil. The quantity of clay will vary with the amount of predistillation and the quality of the raw waste oil. The mixture is then heated to 500-600^{o}F (depending upon the desired type of base oil stock to be produced) and is stripped with super heated steam. This combined clay-steam treatment removes unstable compounds and particulate matter to give the oil its desired colour and odour values.

The vapours from this operation are condensed and decanted. If complete predistillation has been done previously, the organic layer from this step will be small and will be used as an in-plant fuel.

On the other hand, a lower predistillation temperature (less removal of lower boilers before acid treating and clay contacting) will result in the production of a low viscosity lubricating oil from the decanted oil layer. This cut will probably need further clay treatment to attain the required colour and odour levels.

The non-condensed gases from this operation need to be passed through a caustic scrubber to remove H_2S, SO_2, and SO_3 as well as other materials. The water layer will also need to be treated before leaving the plant (will contain oil, phenols, acids, etc.).

e) Filtering

The oil clay mixture is passed through a filter (usually a plate and frame press) yielding a base stock lubricating oil. The clay filter cake will contain about 1 lb of oil per lb of clay in addition to particulate matter and non-stable materials absorbed by it. This mixture is trucked away for disposal at land fill sites. Incomplete predistillation will cause high pressure drops and filtering problems (associated with oxidized aromatics asphaltenes in raw waste oil).

The base stock lubricating oil will be either "C" engine oil category (raw waste diesel oil) or "S" engine oil category (raw waste automotive oil, etc.).

f) Blending

Depending upon the desired end-product and the type of base stock lubricating oil produced, the latter is blended with a specific additive package and, if need be, virgin base stock lubricating oil is also used (i.e., bright stock or 400 neutral oil to adjust for final viscosity properties).

The additive contents of the various oils are:

Diesel lubricating oil "CD" - 10-11% v/v
"CC" - 4-4½% v/v
"CA" - 1-1½% v/v
Straight grade oil (e.g. SAE 20, 30, etc.) - 7-7.5% v/v
Multigrade oils (e.g. SAE 10w30, SAE 5w40) - 11-17% v/v

Typical gasoline engine blended lubricating oil has the following composition.

Ingredient	Percentage Content
1) Base Oil	86
2) Antiwear Additive (ZDDP - Zinc dialkyl dithiophosphates)	< 1
3) Detergent (barium and calcium sulfonates)	4
4) Multi-functional Additives (dispersant, pour-depressant, Vl improver-polymethy methacrylates)	4
5) Viscosity Index Improver (poly isobutylene)	5
	100

Some multigrade oils are reported to have up to 20% additives. The cost of the additives is usually 50% of the cost of the blended finished product prior to sales tax.

(The additive packages cost about $2.50/gal Nov. '73. See Attachment No. 17 for list of lubricating oil additives.)

There are other processes for re-refining used lubricating oil, all of which are base on removing the volatile impurities and solid material acquired during use and/or collection, such as:

i) solvent extraction followed by distillation and clay treatment,
ii) solvent extraction followed by acid-clay treatment,
iii) distillation followed by hydro treatment, and
iv) distillation followed by clay treatment.

An economic review of the different processes was presented at the International Waste Oil Conference (61). (See Attachment No. 18.) A detailed economic breakdown is given in this paper for each process.

5.4.2 Yields and costs

From the preceding section it can be seen that a significant Proportion of "as received waste oil" is not composed of oil at all. As

well as the additives placed in the oil in its original processing, there are low-boiling impurities (gasoline and volatiles) and also a wide range of solid materials known as bottoms, sediment and water (BS&W). These last two are usually in the following range as a percentage of "as received" oil:

Impurities	% in Used Oil
BS & W	3.2 - 10
Gasoline and volatiles	0.6 - 8
Total	3.8 - 18

In re-refining, there are also "in process" losses. The activated clay usually absorbs an equal weight of oil and/or other materials. The acid sludge produced is a mixture of resins, unsaturated hydrocarbons, some of the original additives in the oil, metals, etc. These "in process" losses are usually in the following range as a percentage of the as-received used oil:

In Process Loss	% of Used Oil
Loss in clay	3 - 4
Loss in Acid Sludge	8 - 14
Total	11 - 18

Thus the total losses are:

	% of Used Oil
Impurities	4 - 18
In process	11 - 18
Total losses	15 - 36

The usual yield of base stock lubricating oil is 65-70% on raw oil feed stocks or 80-85% of the oil content in the feed stocks. An additional 5-15% of the original feed stock is recovered as light oil fractions (used as in-plant fuel or sold as by-products).

Typical costs are as follows:

	¢/gal
Collection costs	4-5
Storage Costs	0-1½
Re-refining costs	24-26
TOTAL COST on re-refined base oil stock	28-32½ ¢/gal

By comparison, the re-refiner would have to pay 53¢/gal (Aug./73 price) for virgin base stock oil, used for blending purposes.

The selling price of the re-refined product depends upon the size of order (quart cans to tank car quantities). The addition of additives will, of course, increase the cost of oil in blended stocks. At this point a cost that has nothing to do with the recycling process enters the picture where blended oils are concerned. Sales tax must be paid on any blended finished grade materials which are not resold to the previous user of the waste oil (see section on Federal Taxing).

5.4.3 Federal taxing

In almost every society taxation has been used not only to produce revenue for government but also to act as an incentive or depressant to selected parts of the economy. The rate of taxation or the withdrawal of taxation can often make the difference between economic viability and economic collapse of a productive endeavour.

In the case of re-refining oil, current tax policy seems to be unclear in its intentions in that it encourages one aspect of re-refining while discouraging others.

Two re-refineries in Canada are currently processing used diesel lubricating oil in tank car quantities for railway companies. Such lots are processed separately and are blended to meet the requirements of the companies' specifications using approved additive packages. No sales tax is applied because the oil is being returned to the original user.

When, however, journal box oil for the railways is produced from re-refined automotive crankcase oil, a process that involves the blending in of additives to meet the railways' specifications, sales tax is applied. Such oil is a) being sold to someone other than the

previous user and b) has additives blended in, and is therefore subject to sales tax.

Such a policy has not always been in effect.

On July 6, 1967, the Department of National Revenue, Customs and Excise, stated in writing (27) to the re-refining companies that their products were exempt from sales tax as the "adding of demulsifying agents or petroleum additives to reclaimed lubrication oils is not regarded as a taxable process of manufacture for the purpose of the Act, and accordingly your company will not be required to operate under a manufacturer's sales tax licence for these specified operations".

On August 29, 1972, (28,29) the Department of National Revenue, Customs and Excise, reversed its decision, as follows:

"For the purpose of the Excise Tax Act the manufacture or production of dust-laying oil and the production from purchased waste oils of re-refined oils into which you blend additives, are taxable processes of manufacture and you are required to account for tax on your taxable sales of these products.

"The reclaiming of used lubricating or similar oils from used oil supplied by a customer is not considered to be a taxable process of manufacture when the reclaimed oil is returned to the same customer, whether or not additives are blended with the reclaimed oil. Also, where you only re-refine used oil purchased by you, with no further processing (such as blending of additives), such operations are not considered to be a taxable process of manufacture."

The net effect of this decision is to diminish the economic appeal of re-refining oil except for those large users such as railways who can purchase back their own oil. For the majority of both producers of waste oil and prospective purchasers of re-refined oil the economic appeal of recycling is reduced.

As the correspondence from the Department of National Revenue, Customs and Excise indicates, no tax is applied against re-refined oil that lacks additives. The market for such a product, however, is doubtful. According to preliminary studies by the U.S. Bureau of Mines, re-refined non-compounded lubricating oil (no additives added) lacks

lubricating power (49).

Additives are essential for lubricating oil to meet the pressures and loads of modern engines and machinery. They represent about 50% of the cost of the final blended product. Even if no sales tax were applied to re-refined oils with additives, the product might still have difficulty gaining widespread market acceptance given the suspicion that exists that somehow a re-refined oil cannot be as good as an original oil.

Present legislation in Canada therefore encourages large industrial concerns which have large volumes of used oil (usually tank car lots) to have their oil re-refined since no sales tax is applied. Smaller companies, which cannot accumulate enough oil for custom re-refining to suit their needs - but in the overall scheme of things, the largest market for oil - have to pay tax on re-refined oil and are therefore discouraged from buying recycled oil.

In the United States a comparable situation exists. A sales tax ruling in 1965 (The Excise Tax Reduction Act, 30), coupled with a labelling requirement (previously used lubricating oil) (31) by the Federal Trade Commission, was to a large extent responsible for the elimination of more than 50% of the companies engaged in re-refining used oil in the United States (1966 - 125; 1972 - 50) (32).

In striking contrast to Canadian tax policy is that of the German Federal Republic (West Germany). There the "1968 Waste Oil Law" provides, among other things, an economic rebate according to the following schedule:

a)	recycled to lubricating oil	DM 12.5/100 kg
b)	recycled to fuel oil	DM 10.2/100 kg
c)	incineration	DM 10/100 kg

Italy also has a rebate system to encourage the recycling of lubricating oils.

Three bills (33, 34, 35) were proposed to the U.S. Federal Government in 1973, not only to negate the decisions taken in 1965, but also to provide, among other things, for:

a) development of government specifications allowing recycled material to be used in government vehicles and equipment. (The Canadian Government has permitted the use of recycled oil in commercial vehicles (36) but not in tactical vehicles (37)).

b) requirement for government agencies to purchase recycled material; and economic incentives for collecting and re-refining oil.

It is undeniable that re-refining can be an economically attractive process, particularly with a favourable tax system. Re-refining has the added advantages of conserving a non-renewable natural resource and putting what would otherwise be a pollutant to valuable use.

Problems, however, exist at both ends of the recycling process. For it to be both large-scale and effective, a system of waste oil collection would have to be instituted that would segregate the wastes and prevent unnecessary contamination. And an acceptable method of disposal of large volumes of acid sludge and other by-product contaminants would have to be devised. These are, however, small problems compared to the overall problem of waste oil disposal.

In terms of market acceptance of re-refined oils, the stigma could be removed by strict adherence to meaningful specifications and by the active participation of the major oil companies in encouraging the recycling of waste oil.

6. EXISTING LEGISLATION

The problem of waste oil disposal is one that directly or indirectly enters into many legislative areas and jurisdictions ranging all the way from municipal to federal. Public Health Acts, Clean Water Acts, Environmental Protection Acts, Industrial Safety Regulations can all be brought to bear on a material that can be considered a pollutant, nuisance, health or safety hazard (see Attachment No. 19 for typical instances of provincial controls). The following is a brief summary of the major legislative controls relating to the problem of waste oil:

6.1 Federal

Under Sections 33 and 34 of the Fisheries Act, the Federal Government has authority to define a deleterious substance and regulate it such that is is an offence to:

> "cause or knowingly permit to pass into, or put or knowingly permit to put chemical substances or any other deleterious substance of kind in any water frequented by fish or that flows into such water".

Oily substances can affect aquatic life by interfering with fish respiration (coating of gills), coating and destroying algae and other plankton, tainting the flavour of fish, upsetting the equilibrium and reducing reaeration and photosynthesis. One study concluded that hydrocarbons were more responsible for tastes in fish flesh than were the phenolic compounds. (The new Federal Petroleum Refinery Regulations used a level of 10 ppm for grease and oil as a basis for calculations.)

Used oils contain heavy toxic metals such as lead and zinc (see Attachment No. 1) and the oil itself is a source of oxygen demand (BOD) in the receiving water. Used oil also contains polynuclear aromatics which may be carcinogenic (see reference in Fuel Use section).

6.2 Provincial

Alberta: In Alberta, Regulation 127/71 under the Department of Labour Act, requires the installation of gasoline, oil, grease and grit interceptors on the waste outlets of all public garages. These interceptors must be of sufficient capacity to intercept all grease or oil

likely to flow into the outlets under normal conditions.

British Columbia: In this province there are regulations "governing the manufacture, sale, storage, carriage and disposal of inflammable liquids and oils" pursuant to the Fire Marshal Act. These contain the following:

> "crankcase oil means any waste oil which has been used in the engine or crankcase of any motor-vehicle."
>
> "Regulations governing the approval, sale, installation and maintenance of oil-burners and oil burning equipment and appliances using inflammable liquids as fuel" pursuant to the Fire Marshal, Act, Province of British Columbia, states in Division 2:05: "No person shall supply for use or use any crankcase oil as oil fuel in any oil burner."
>
> Division 5: Service Stations Generally:
>
> "No operator shall permit any inflammable liquids or any crankcase oil to flow into a public sewer or septic tank or cesspool All waste inflammable liquids or crankcase oil on the premises of a service station shall be kept in steel drums provided with screwplugs, which drums shall at all times be kept closes, except when being filled.
>
> Not more than two drums of a capacity of fifty gallons each shall be kept on the premises of a service station at any time." (underlining added)

Division 6 of this regulation then proceeds with detailed specifications for underground outside storage tanks. (Concerned bodies believe that Division 5 should be deleted and replaced by Division 6 requirements).

Newfoundland: Newfoundland is also drafting regulations ("The Regulations for the Control of Waste Disposal"), under the authority of "The Waste Material (Disposal) Act, 1973". These include the following definitions:

> "handled liquid industrial waste means liquid waste that

results from industrial process or manufacturing or commercial operations and that is transported in a tank or other container for treatment or disposal, and includes sewage residue from sewage works.

handling waste means waste that requires special precautions in its storage, collection, transportation, treatment or disposal, to prevent damage to persons or property and includes explosive, flammable, volatile, radioactive, toxic and pathological waste."

Under the regulations, approval must be obtained for all phases of a waste management system before an operator can engage in any phase of it. The Act requires licensing, submission of plans, specifications, and payment of fees for pick-up of waste from the occupier of premises from which waste material is collected. It also forbids the dumping or disposing of waste except in an approved manner.

Ontario: The handling of waste oil in Ontario is regulated by the Ontario Gasoline Handling Act, 1969 and the Gasoline Handling Code. The Act pertains to gasoline and associated products which are defined as "any product of petroleum, other than gasoline, wax and asphalt". It includes the following definition:

"handling means the storing, transmitting, transporting or distributing of gasoline or an associated product, and includes the transfer of gasoline or an associated product into the fuel tank of a motor vehicle, motor boat or other water craft or into a container." Regulations under the Act also cover, annual licence fees and the approval by the authorities of all equipment used for handling the materials. (underlining added)

Waste oil handling in Ontario also comes under "The Regulations Made Under the Waste Management Act - Regulation 824, August 1973". It covers, hauled liquid industrial waste and its collection under the following definitions:

"liquid waste, other than hauled sewage, that results from

industrial processes or manufacturing of commercial operations and that is transported in a tank or other container for treatment or disposal"

and

"hauled liquid and hazardous waste collection system means a waste management system or any part thereof for the collection handling, transportation, storage or process of hauled liquid industrial waste or hazardous waste but does not include the disposal thereof."

Thus waste oil collectors, road oilers, etc., must be licensed under both Acts in Ontario.

Quebec: In Quebec, licensing is done under an Order in Council 1967-72, July 4, 1972: "Regulation of the Disposal of Chemical and Combustible Materials". This was authorized under paragraph 11 of Section 16 of the Public Health Act ("may make regulation to regulate the manner of disposing of garbage, refuse and fibre".)

The order in Council defines:

chemical waste as: "any residue, refuse, liquid or semi-liquid sludge, of a combustible nature, composed of oils, hydrocarbons, solvents, polymers or other chemical products so recognized by the Ministry";

treatment work as: "establishment utilizing an industrial process for incinerating, recycling, destroying, converting or transforming chemical waste." (underlining added)

This regulation covers approval of the site, storage tanks, and treatment works and record-keeping of all waste materials received (quantity, source, disposal, etc.).

At the present time, there are six licensed collectors in Quebec. The major oil companies have notified the service station operators of the legal requirements of dealing with a licensed pick-up service. At the moment there are about sixteen firms dealing with waste oil pick-up and road oiling in the Montreal area of the province.

Regulations to supersede the above are now being drafted under Division 7 (Waste Management) of Bill 34, "Environment Quality Act, December, 1972." This Bill includes the following definitions:

> waste: "solid or liquid residue from industrial, commercial, or agricultural activities, rubbish, household garbage, used lubricant..."
>
> waste management system: "a combination of administrative and technical operations ensuring a rational method of removal, transport, storage, treatment and final deposit of waste and the removable and immovable property set aside for such purposes "

Division 7 of the Act also covers permits, reporting, terms of operating, selling, depositing, etc. of waste materials. It also forbids the deposit of such material except in an approved manner:

> "No one may deposit waste in a place other than a site for elimination or storage of waste or a waste treatment plant approved by the Director...."

Quebec has also the "Petroleum Products Trade Act", Chapter 33, which covers the storing, handling and transport of petroleum products, the latter being defined as:

> "any liquid petroleum product determined by regulations, except liquified gas".

Section 29 of this Act, "Drainage and Waste Disposal" states:

1) Used petroleum products or waste material shall be gathered either in a tank or in a closed container.

   a) If they are gathered in a tank:

      i) the tank shall be buried outside the building;

      ii) the filling pipe might be inside or outside, but shall be kept tightly closed when not in use;

      iii) the tank shall be equipped with an air vent opening on the outside according to Section 36.

   b) If they are gathered in closed containers, all in-

structions of the Regulations regarding Class 1 products shall be followed.

2) Any drainage from outside service bays built after January 1st, 1974 shall be done through the use of a hydrocarbon separator.

3) The petroleum products floating in the separator shall be removed regularly so that it does not drain into the sewer, and the operator shall transfer them to the petroleum waste tank or to the closed container, whatever the case may be.

4) The tank and the closed containers used for petroleum waste shall be emptied regularly.

There is also Bill 23, "The Transport Act" in which "specialized transport" includes "transport of domestic and industrial waste". These two acts have the authority to control the storage and shipment of used lubricating oils.

Saskatchewan: There are no specific laws or regulations governing used oil in Saskatchewan. There is, however, legislation under which such regulations could be enacted such as the Water Resources Management Act, 1972, and the Public Health Act. There is a statute prohibiting dumping of oil in a sanitary land fill site other than a specific site approved by the Minister of the Environment. There are two sites, one each in Saskatoon and Regina, for oily wastes.

6.3 Municipal

There are a number of cities and towns which have specific by-laws for limiting the dumping of waste oil into the city sewers such as:

1) Corner Brook, New Foundland. A by-law limits the discharge of any waste hydrocarbon into city storm sewers or sanitary sewers.

2) City of Ottawa. By-law No. 98-61 states that no person shall discharge or cause to discharge into any public sewer any water or waste which contains more than 100 ppm of fat, oil or grease. This by-law also requires that grease, oil and sand interceptors be installed as per City drawings and specifications.

3) City of Edmonton. By-law No. 3875 limits the oil and grease content to 200 ppm for material going into city sewers. It also states: "Grease, oil and sand interceptors shall be provided on private property for all garages, gasoline service stations, and vehicle and equipment washing establishments... shall be maintained by the Owner at his expense in continuously efficient operation at all times".

4) City of Toronto. By-law No. 2520 limits, in sanitary sewers, waste water containing more than 150 mg/l of fat, oil or grease, 15 mg/l of floating material and 150 mg/l of emulsion material. In storm sewers, the limit is 15 mg/l of fat, oil, grease or other material soluble in petroleum ether. Waste water must not exceed a BOD demand of 20 mg/l. It also requires grease, oil and grit interceptors.

From the above it can be seen that there is a need at all levels of government for comprehensive and effective regulations covering oil and other liquid wastes both to minimize health and environmental hazards and to rationalize the storage and transportation of such wastes. Among other things such regulations would require that:

a) Used Lubricating oils be stored in properly designed containers,
b) Used Lubricating oils be collected only by authorized collectors who keep adequate records of the sources, quantities, descriptions and "drop-off points" of all such materials,
c) Only approved and licensed end-users be permitted and only ultimate disposal plants, firms or sites which would receive, handle, process or dispose of such materials in an approved manner and keep adequate records to account for all materials received be allowed to operate,
d) Maximum limitations be established for the amount of oils discharged into sanitary sewers,
e) The discharge of oils into storm sewers be prohibited,
f) The dumping or disposal of used oils in such places or in such manner that they would do environmental damage be prohibited.

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APPENDIX

CANADIAN LUBRICATING OIL SALES

CANADIAN LUBRICATING OIL SALES

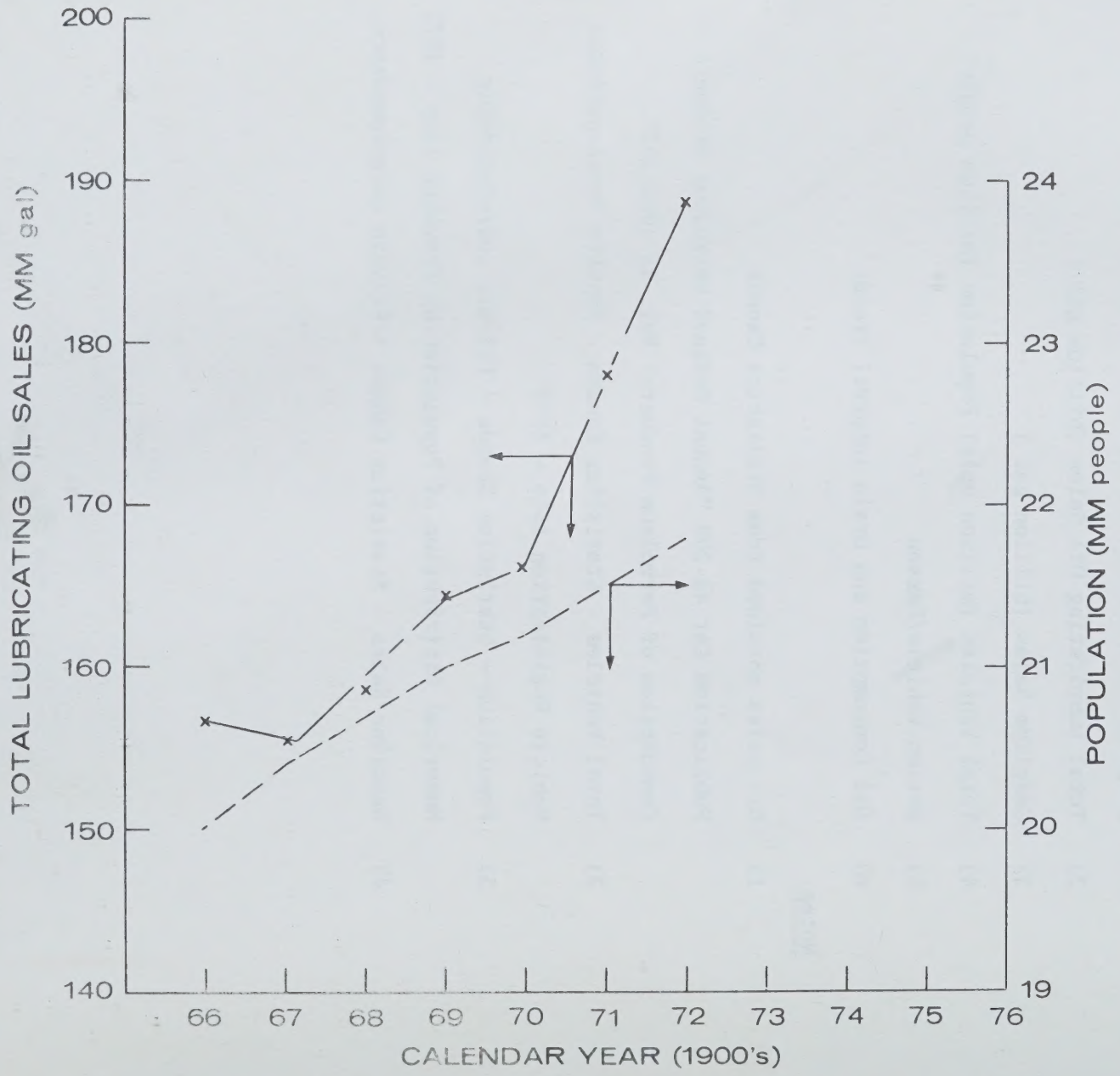
Graph number:

1) Total Lubricating Oil Sales (million gal) Population (million people)
2) Total Lubricating Oil Sales (billion gal)
3) Gasoline Sales (billion gal)
4) Total Vehicles (million unit) Population (million people)
5) Ration Vehicle/Person
6) Oil Consumption and Drain Interval Trends

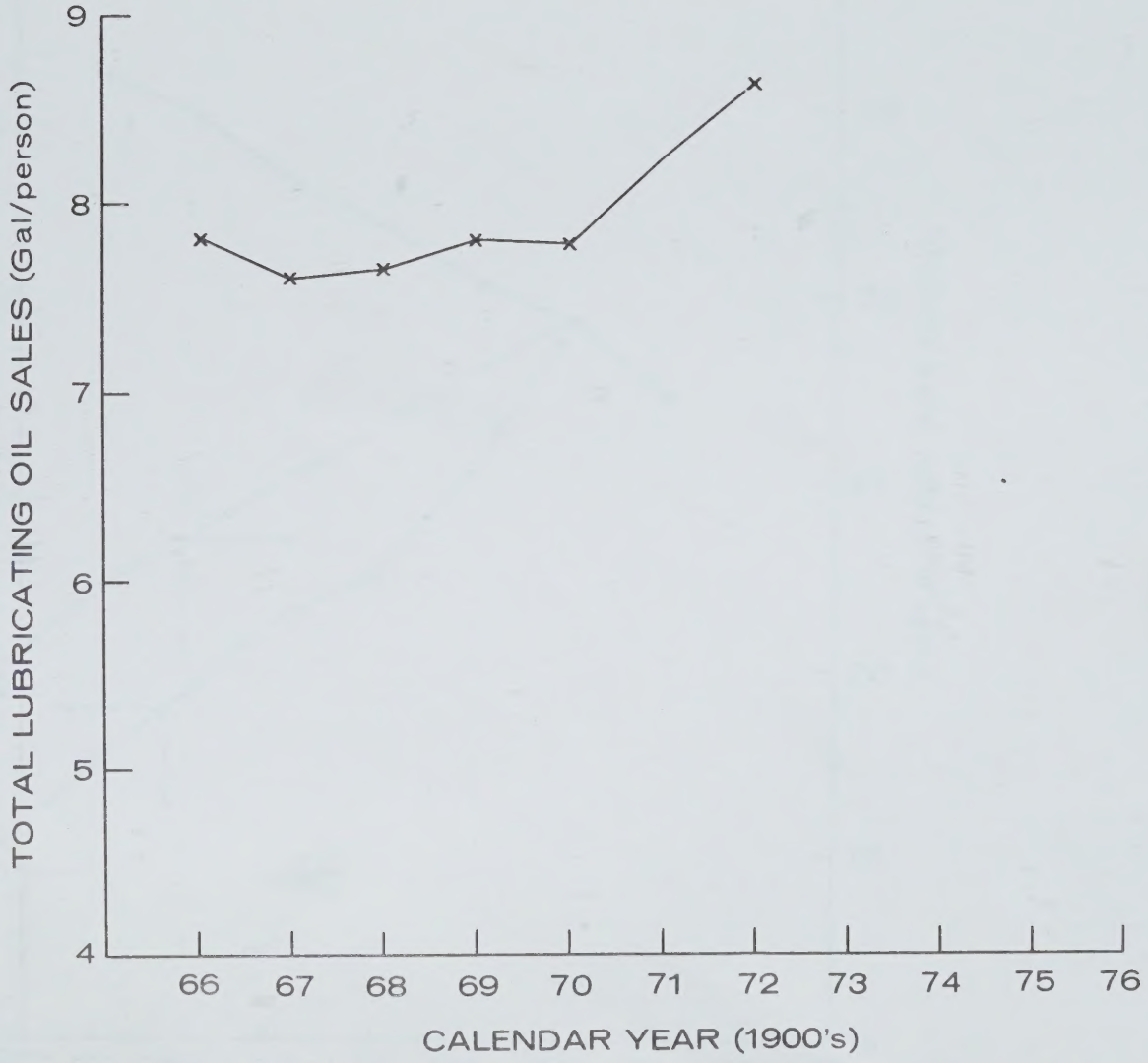
Notes:

1) Oil sales obtained from Statistics Canada
   Publication Cat 45-208 "Annual Refined Petroleum Products - Consumption of Petroleum Products" Vol. 11 1966-1972.
2) Total Vehicles - Statistics Canada - Private correspondence
   Vehicle Registration 1966 - 1972
3) Population - Statistics Canada - Private correspondence
   Numerical Distribution of Population by Province 1966 - 1972
4) Gasoline Sales - Statistics Canada - Private correspondence.

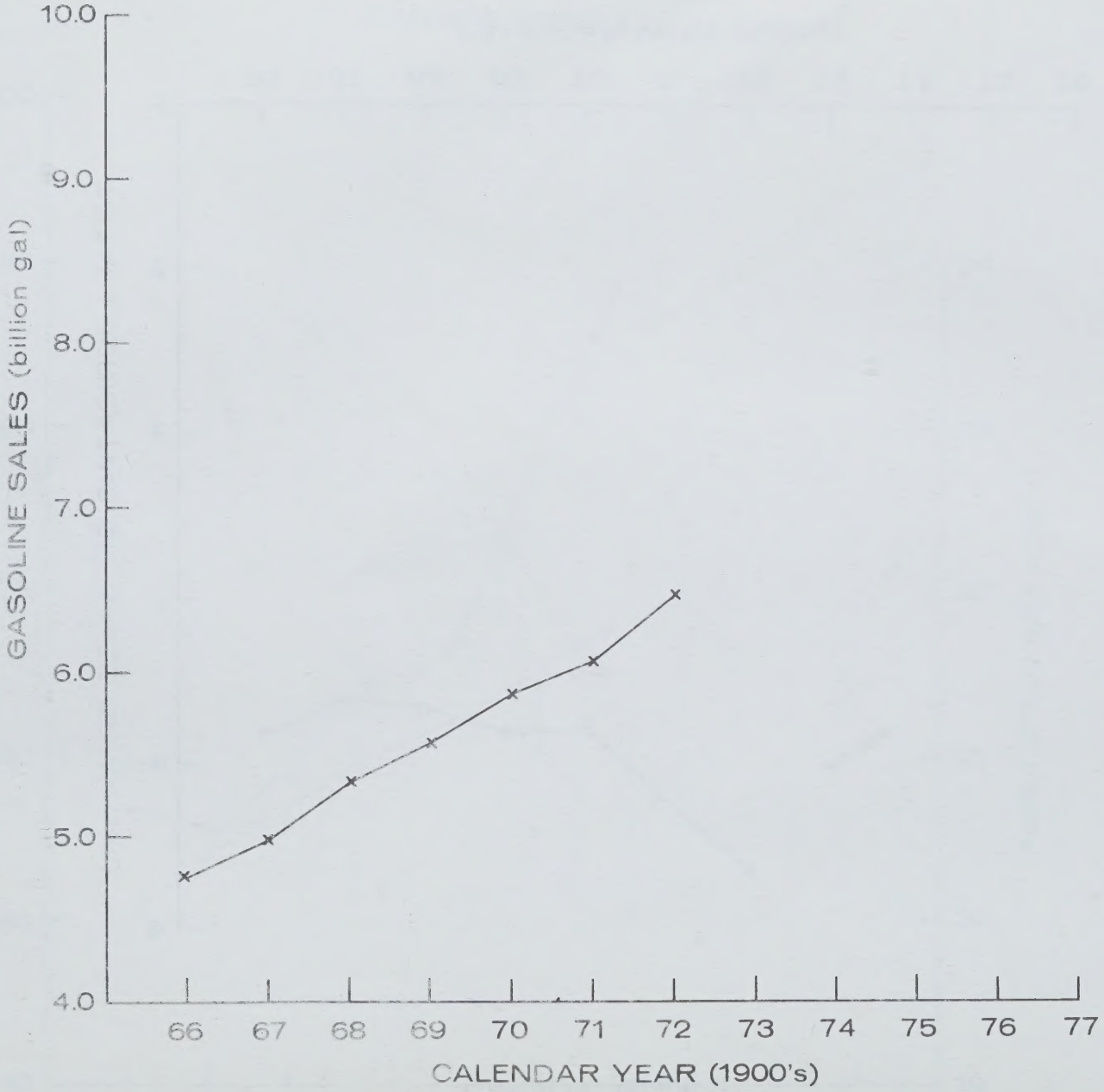
CANADA -Graph 1



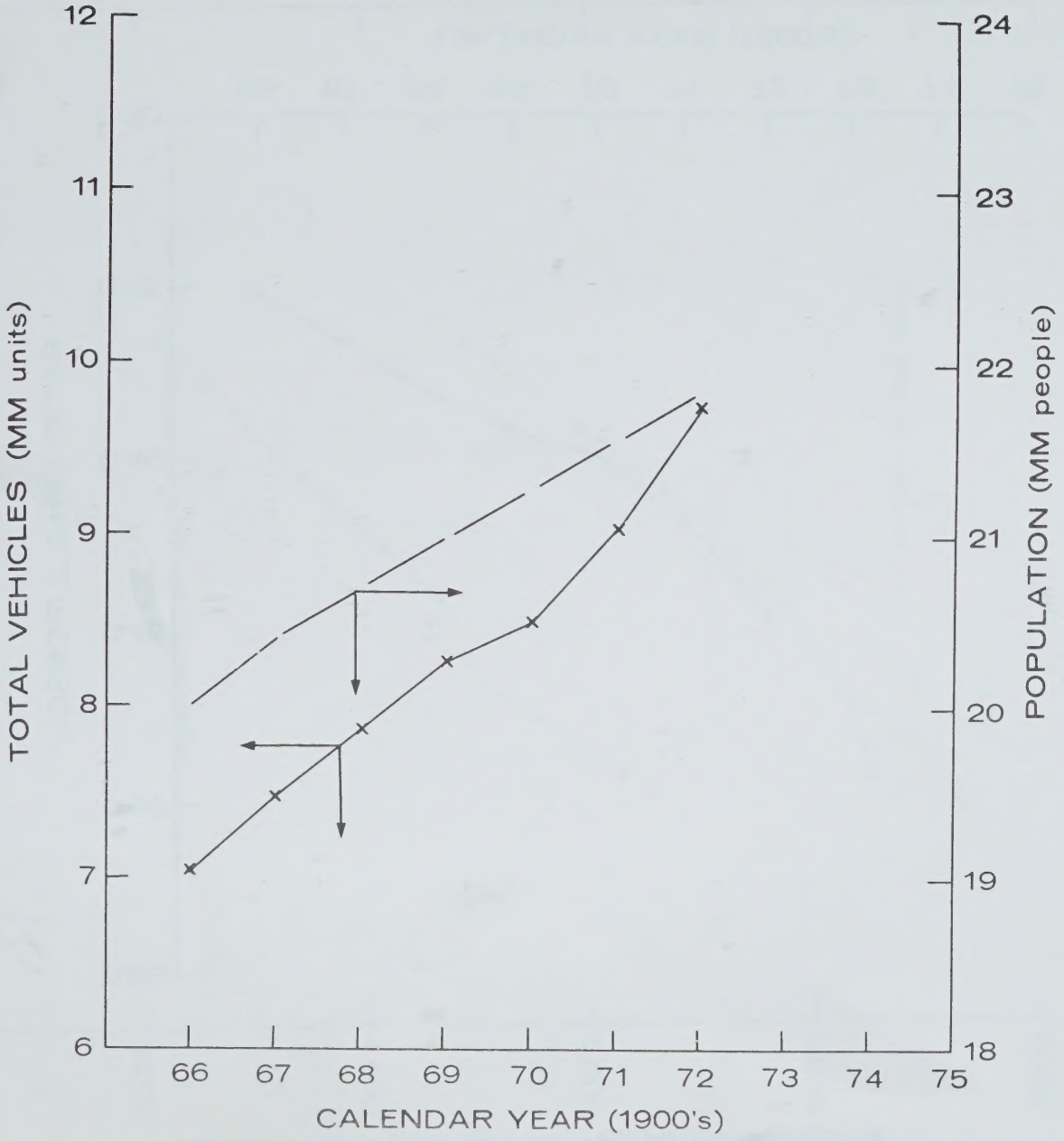
CANADA -Graph 2



CANADA -Graph 3



CANADA -Graph 4



CANADA -Graph 5

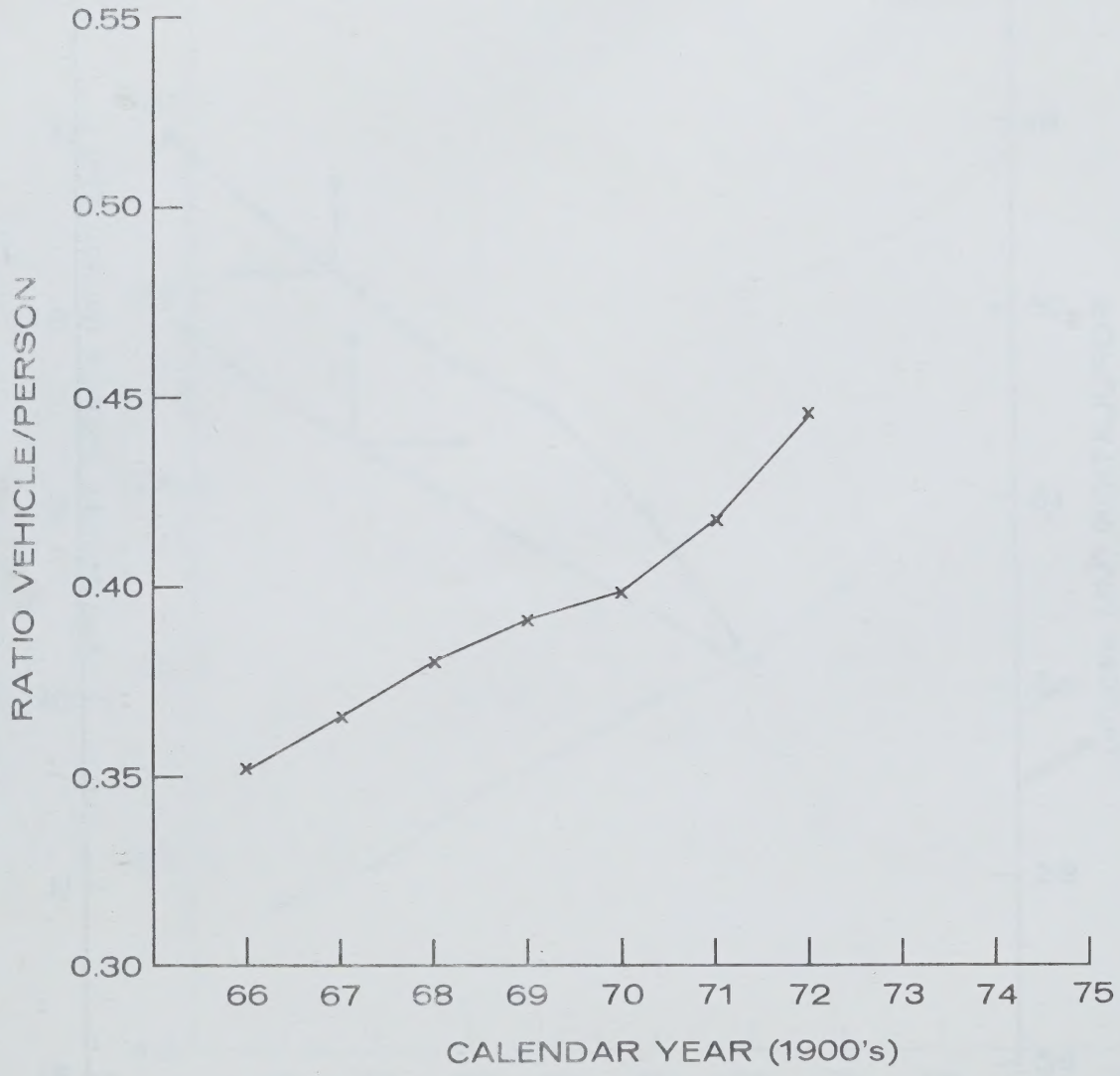
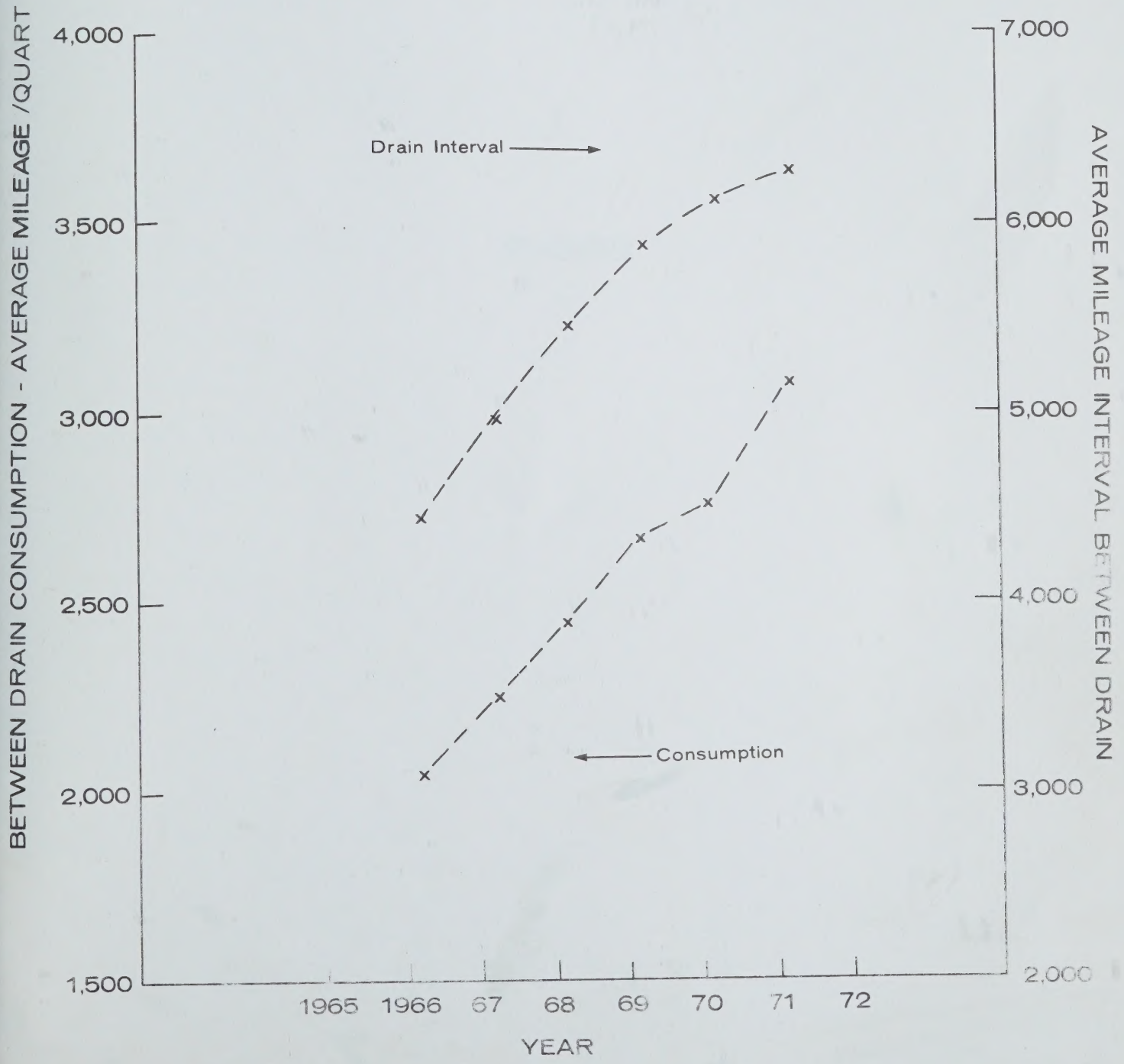


Figure 6

Oil Consumption And Drain Interval Trends

Source: NPN Fact Books & Monthly Publications Servise Station Sales



ATTACHMENTS

Attachment No. 1A (8)

TYPICAL WASTE AUTOMOTIVE OIL COMPOSITION

Variable	Value
Gravity, ^{o}API	24.6
Viscosity @100 ^{o}F	53.3 Centistokes
Viscosity @210 ^{o}F	9.18 Centistokes
Flash Point	215 ^{o}F (C.O.C. Flash)
Water, (By Distillation)	4.4 Volume %
BS & W	0.6 Volume %
Sulphur	0.34 Weight %
Ash, Sulphated	1.81 Weight %
Lead	1.11 Weight %
Calcium	0.17 Weight %
Zinc	0.08 Weight %
Phosphorus	0.09 Weight %
Barium	568 ppm*
Iron	356 ppm*
Vanadium	5 ppm*

* ppm = parts per million

Attachment No. 1B (8)

USED AUTOMOTIVE LUBRICATING OILS

TRACE METALS CONTENTS

Metal	Parts Per Million	
	Average	Range
Aluminum	16	10 - 30
Copper	28	5 - 120
Iron	361	150 - 100
Lead (1)	15240	9600 - 20700
Silicon	46	10 - 240
Tin	30	30
Sodium	64	20 - 110
Barium	269	10 - 900
Calcium	1772	1160 - 2690
Zinc	1111	560 - 1610
Magnesium	155	10 - 420

Note: (1) lead figures multiplied by 10 due to printing error in reference literature (8).

ATTACHMENT NO. 1C (51)

WASTE LUBRICATING OIL IMPURITIES

IMPURITY	SOURCE																	
	Service Stations 36 samples			Truck Fleet (5) 12 samples			Taxi Fleet 12 samples			Off-Road Fleet 12 samples			Zone Composite 13 samples			Collection Services 8 samples		
	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.
Free H_2O% V/V	neg	10.1	7.3	neg	neg	neg	neg	21.0	2.2	neg	21.0	2.2	—	—	—	neg	2.0	0.4
1)Total H_2O% V/V	0.2	16.8	9.8	neg	6.4	1.3	0.2	13.8	2.8	0.2	13.8	12.8	1.0	16.0	4.9	2.0	24.0	9.7
2)Flash point °F	75	465	374	175	485	350	170	440	332	170	440	332	195	399	304	205	360	288
Sulphate Residue ppm	16,900	64,300	34,300	1,900	21,500	8,570	14,800	54,400	26,600	4,500	44,000	13,500	9,080	34,100	22,000	4,600	19,700	9,500
Sulphur ppm	1,960	5,340	3,830	2,370	5,410	3,780	2,260	6,180	3,920	2,260	6,180	3,920	2,900	4,790	3,930	1,790	4,390	3,240
Phosphorous ppm	478	1,330	1,130	798	1,620	970	810	1,130	920	810	1,130	924	490	1,170	917	388	1,080	560
Lead ppm	5,580	21,700	13,700	< 1	5,410	696	4,600	20,800	9,650	< 1	9,230	1,700	5,070	12,000	8,200	1,430	8,740	4,450
Calciunm ppm	462	2,280	1,460	6	1,970	970	210	1,860	1,440	211	1,860	1,440	784	2,240	1,230	600	1,120	580
Zinc ppm	708	1,790	1,140	456	1,000	765	554	1,420	1,020	554	1,420	1,020	688	1,170	894	242	983	530
Barium ppm	1	161	63	1	2,080	390	2	323	52	2	323	52	12	285	88	7	301	54

Notes:

1) by distillation

2) relative measurement of low boiling point content.

3) neg - negligible.

4) ppm - parts per million by weight.

(5) primarily diesel truck fleet.

Attachment No. 1D (50)

RANGE OF PROPERTIES OF USED LUBRICATING OILS

Property		Value Min.	Max.
Gravity, API at 60°F		20.7	27.9
Specific Gravity		0.887	0.934
Density	lb/US gal	7.40	7.78
	lb/Can gal	8.90	9.35
Viscosity, SUS at 100°F		87	837
	centistokes	17.3	180.6
Pour Point	°F	<-40	-30
Flash Point	°F	175	415
Heating Value	BTU/lb	13,571	19,300
	BTU/US gal	105,555	143,360
	BTU/Can gal	126,560	171,890
Neutralization Number	mg KOH/g	4.0	14.3
B S & W	%v/v	0.1	22.0
Sulphur	% w/w	0.21	0.65
Ash	% w/w	0.03	3.78
Silicon	ppm	10	875
Calcium	ppm	700	3,000
Sodium	ppm	16	300
Iron	ppm	50	2,000
Magnesium	ppm	10	1,108
Lead	ppm	800	21,700
Vanadium	ppm	3	39
Copper	ppm	5	348
Barium	ppm	10	2,000
Zinc	ppm	300	3,000
Phosphorus	ppm	500	2,000
Tin	ppm	5	112
Chromium	ppm	8	50
Nickel	ppm	3	30
Beryllium	ppm	6	
Magnesium	ppm	5	10

Attachment No. 1D (50) Cont'd

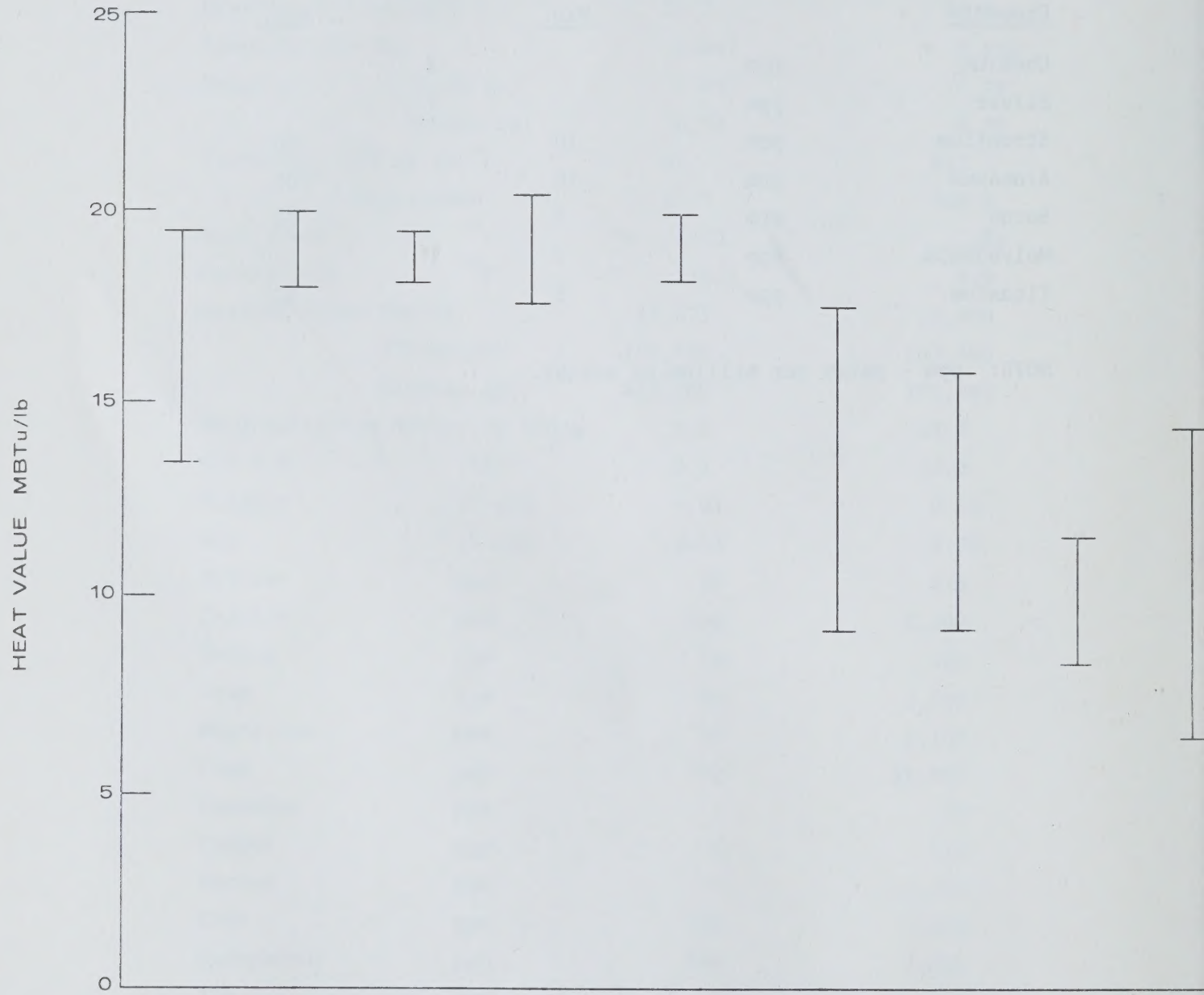
RANGE OF PROPERTIES OF USED LUBRICATING OILS

Property		Value Min.	Max.
Cadmium	ppm	4	
Silver	ppm	1	
Strontium	ppm	10	30
Aluminum	ppm	10	800
Boron	ppm	3	20
Molybdenum	ppm	2	3
Titanium	ppm	5	30

NOTE: ppm - parts per million by weight.

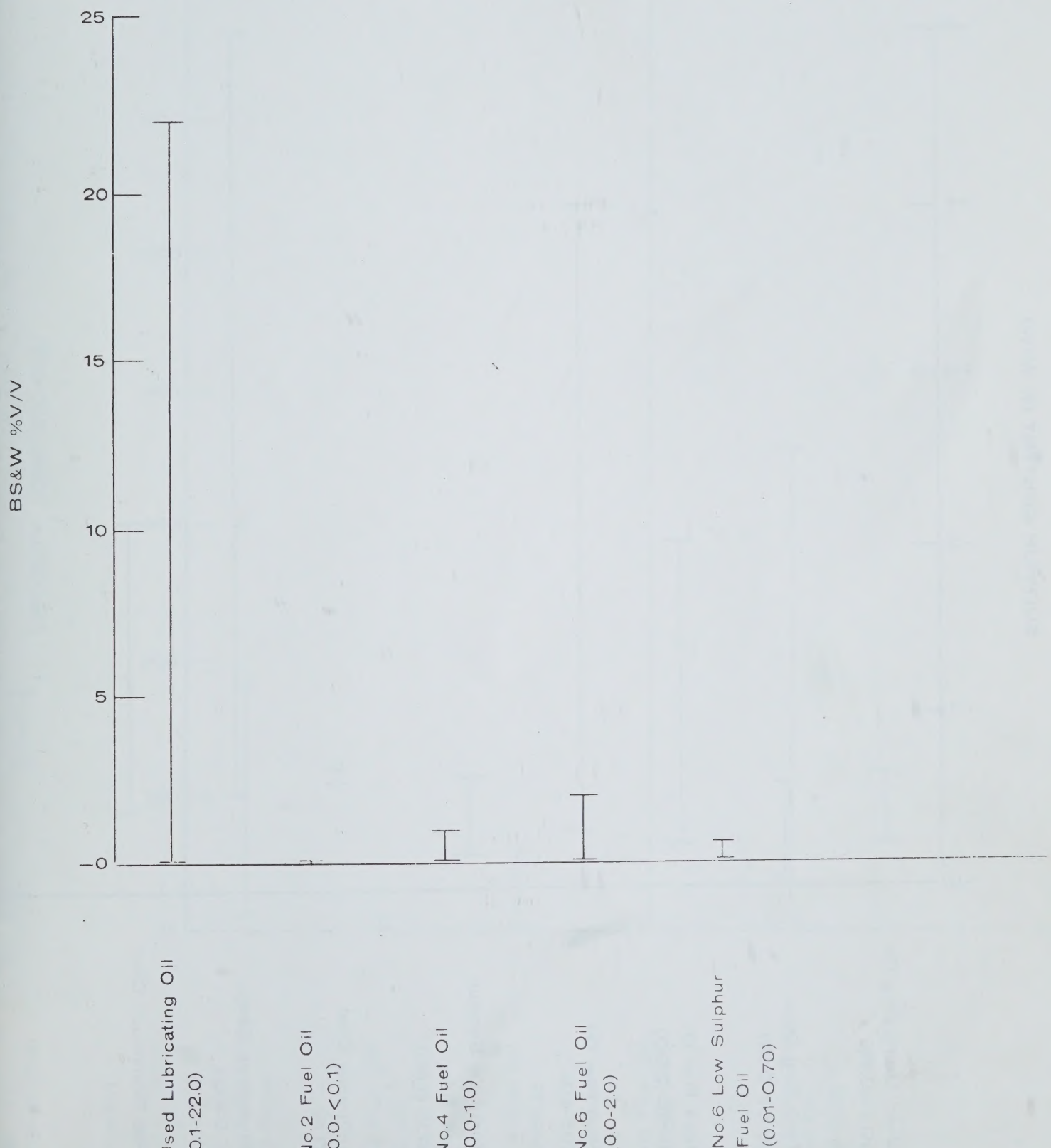
ATTACHMENT NO. 2 (50)

HEAT VALUES OF FUELS



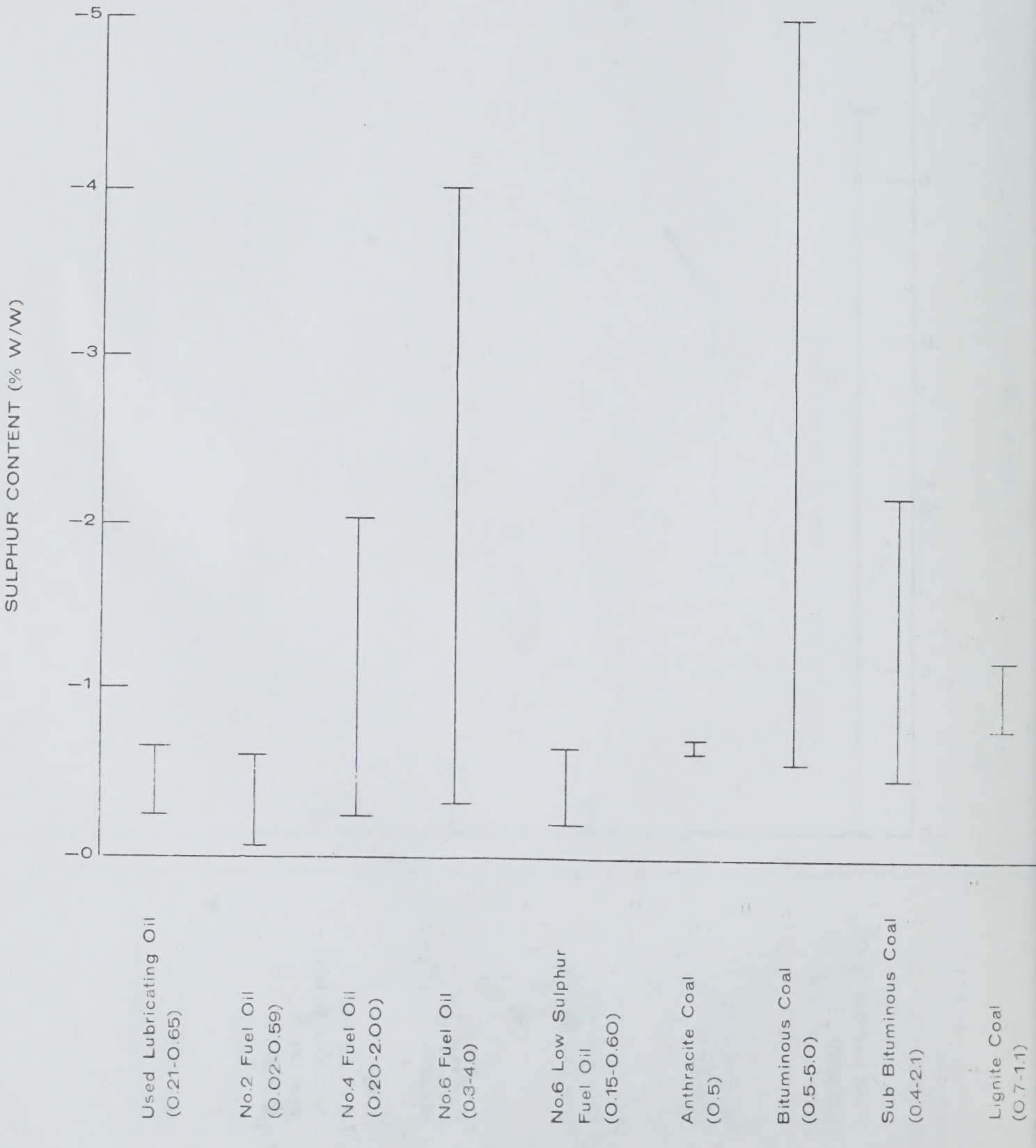
ATTACHMENT NO. 3 (50)

BS&W CONTENT OF FUELS

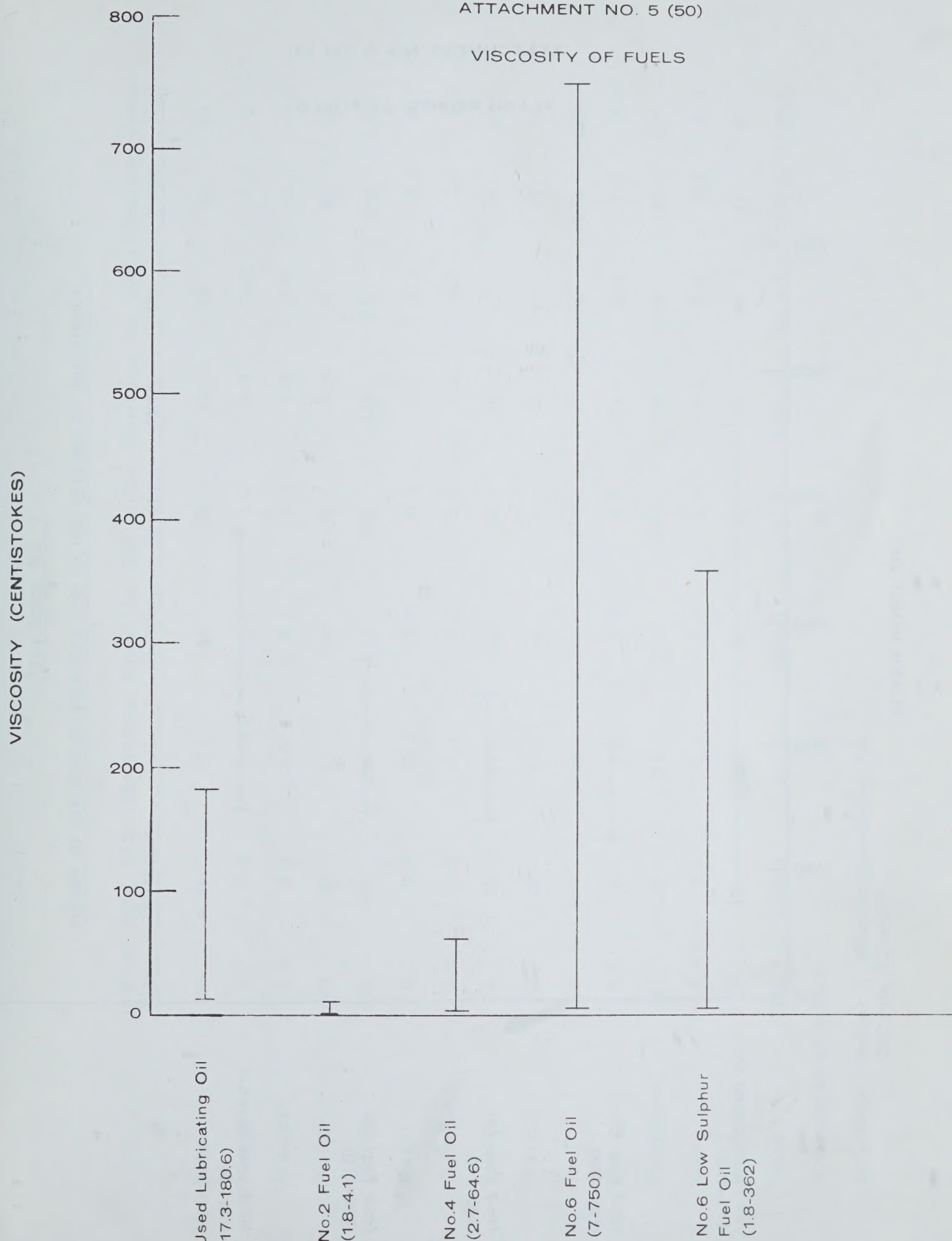


ATTACHMENT NO. 4 (50)

SULPHUR CONTENT OF FUELS

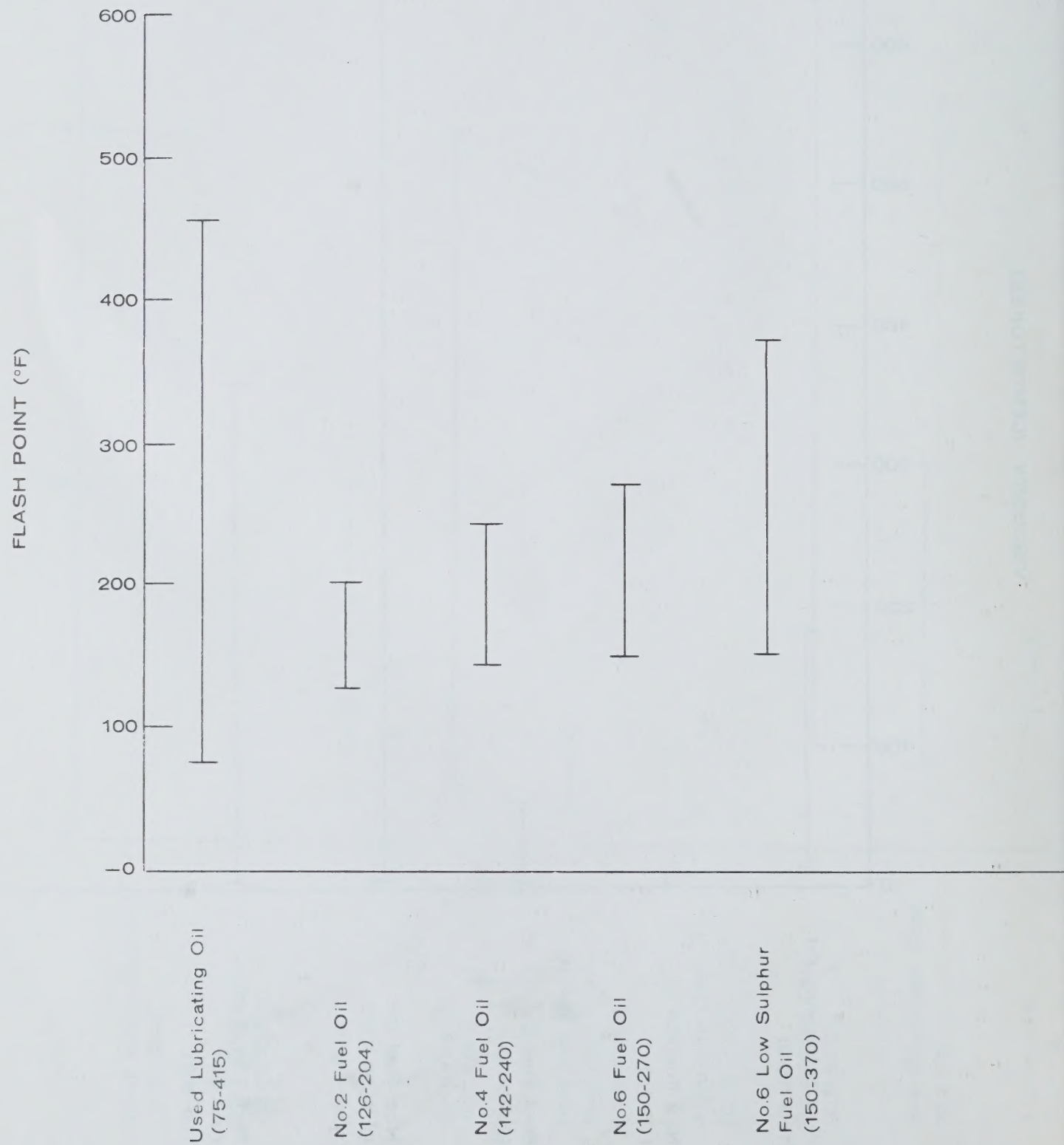


ATTACHMENT NO. 5 (50)



ATTACHMENT NO. 6 (50, 51)

FLASH POINTS OF FUELS



Attachment No. 7

POUNDS OF COMBUSTION PRODUCTS PER 10,000 GALLONS OF DRAININGS*

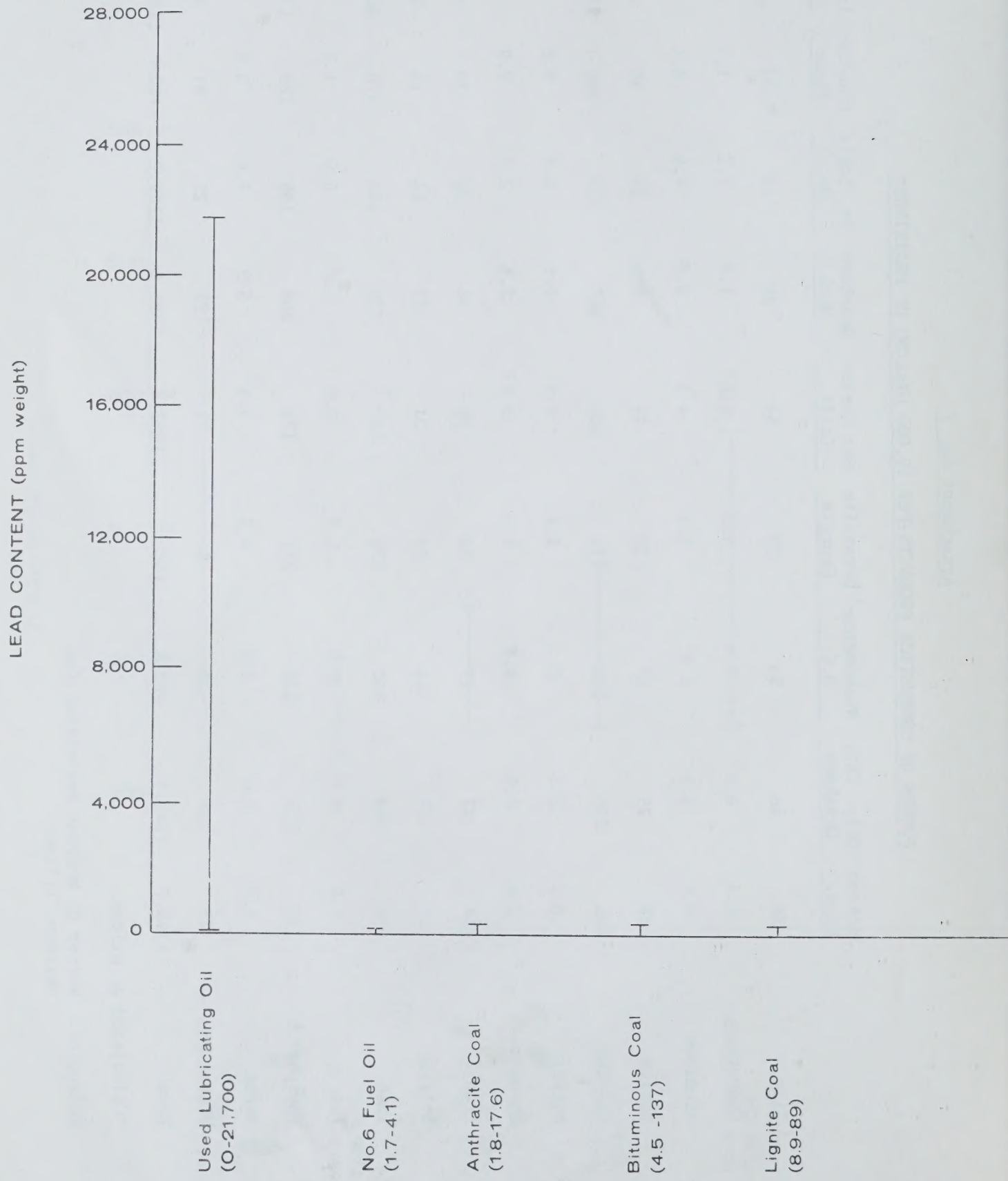
	Jackson Miss.	Okla. City Oklahoma	Washington D.C.	Doraville Georgia	San Carlos Calif.	Dearborn Mich.	St. Louis Mo.	Houston Texas	Lyons Ill.
Zinc	36	46	58	33	54	45	32	32	44
Copper	1.1	0.9	1.4	1.2	1.6	1.4	1.2	1.3	1.5
Aluminum	4.6	5.1	2.6	5.1	4.4	4.8	4.5	4.4	0.3
Barium	43	25	57	20	31	9.3	33	45	38
Calcium	136	220	162	131	220	147	120	162	168
Nickel	0.2	0.3	0.3	2.4	0.5	0.6	0.3	0.9	0.7
Chromium	2.6	2.9	4.8	1.5	3.8	2.6	2.2	2.9	1.2
Iron	34	32	17	30	28	36	32	30	42
Silicon	29	22	13	24	24	27	64	19	24
Lead	650	650	400	570	480	720	650	570	650
Tin	0.6	0.6	0.6	1.0	0.9	1.0	0.9	1.3	0.9
Phosphorus	225	225	225	211	173	264	189	189	178
Boron	3.6	3.6	2.8	4.3	3.6	5.9	3.6	3.8	5.9
Magnesium	23	10	23	36	19	31	25	61	25
Total	1188.7	1243.4	997.5	1070.5	1043.8	1295.6	1157.7	1122.6	1180.5

*Calculated as oxides.

Reference: Walter C. McCrone Associates Inc.
Chicago, Illinois.

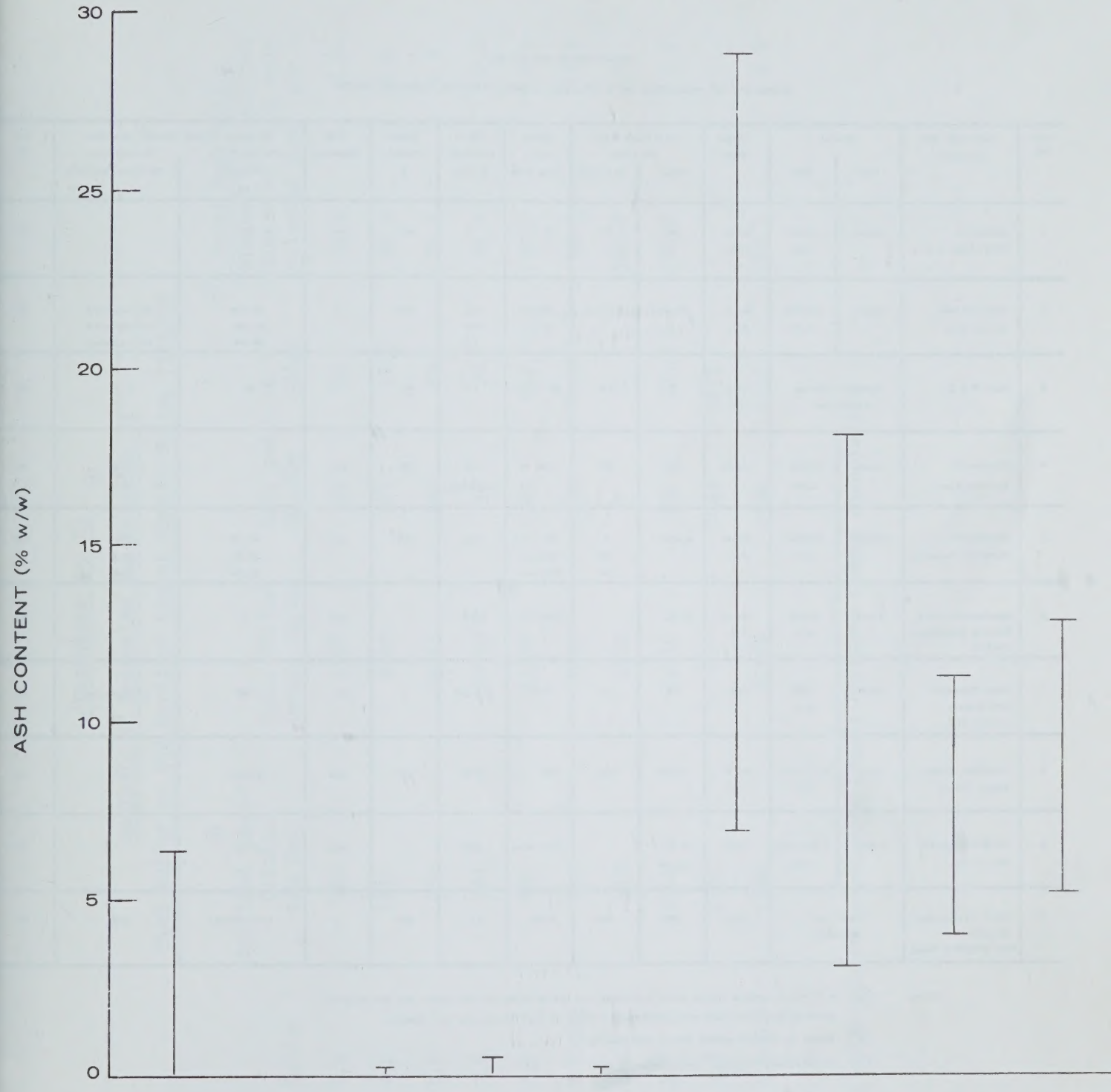
ATTACHMENT NO. 8 (50, 51)

LEAD CONTENT OF FUELS



ATTACHMENT NO. 9 (50,51 ')

ASH CONTENT OF FUELS



ATTACHMENT NO. 10 (49)

SUMMARY OF AVAILABLE DATA ON USED LUBRICATING OIL BURNING TESTS

Test No.	Company and Location	Burner Type	Burner Size	Virgin Fuel	Fuel Feed Rate US gal/hr Total	Fuel Feed Rate US gal/hr Used Oil	Used Oil in Total Fuel	Pb in Used Oil % w/w	Stack Height ft	Soot Blowing	Emission During Normal Operation Pb out/Pb in % w/w	Emission During Normal Operation Ground Level Pb Conc. (μg/m³)	Ref. No.
1	Mobil Oil Port Mobil, N.Y.	steam	18,000 lb/hr	No 6 F.O.	147	5	5% V/V	1	60	Yes	50	1	20
2	Shell Oil Ref. Wood River	steam	60,000 lb/hr	No 6 F.O.	80-850	61-346	36-89 % v/v	0.5 0.8 1.0	130	no	42-106 (1) 20-26 28-34	not reported not reported not reported	20
3	Gulf R & D	Domestic Home Oil Burner		No 2 F.O.	3	0.8	25 % v/v	1.1	15	no	28	< 5	20
4	Humble Oil Sewell's Point	steam	17,000 lb/hr	none	100	100	100 %	not reported	35	yes		< 0.05 0.67 (2)	20
5	Humble Oil Baltimore Terminal	steam	75,000 lb/hr	No 6 F.O.	≈ 400	4 20 60	1% v/v 5% v/v 15% v/v	0.8	25	yes	44-70 33-51 21-24	0.11 0.34 0.54	53
6	Aberbeen Proving Groand, Edgewood Arsenel	steam	5,000 lb/hr	No 2 F.O.	≈ 40		30% v/v	0.67		no	≈ 3		50
7	Esso Research and Enging Linden, N.J.	steam	1,000 lb/hr	none	7.5	7.5	100	0.4-0.6	–	no	< 50	not reported	52
8	Hawaiian Electric Oshu, Hawaii	steam	≈20,000 lb/hr	No 6 F.O.	1,900	140	7.5% v/v	0.45	137	yes	25-29	0.11	49
9	Northern States Power Co.	steam	≈500,000 lb/hr	coal	≈ 30 ton/hr		3.1% w/w	0.65	–	yes	24-61 (3)	–	50
10	GCA Technology Division New Bedford, Mass.	Municipal Incinerator		none	300	300	100%	1.0	100	no	not reported	0.05	50

Notes:
(1) A 15 minute sample during which 3 minutes was soot-blowing; sample results are low because sampling technique could not quantitatively pick up all lead loss during soot blowing.
(2) based on ambient sample during soot blowing.
(3) includes lead collected in precipitator fly ash.

Attachment No. 11

Analysis of Retention and Emission of Fuel Sulfur in the Portland Cement Manufacturing Process

Fuel Type(s)	% Sulfur	Portland Cement Clinker ton/day	Total Sulfur input, lb/day	Exit gas - lb SO_2/day	lb S/day	% Total Fuel sulfer retained in clinker or collected dust	% Total Fuel sulfer emitted in exit gas
Coal	1.4	637	6192	98	49	99.2	0.8
Coal	2.0	1237	9262	117	58.5	99.4	0.6
Coal	1.6	950	9903	168	84	99.2	0.8
Coal	2.5	794	10620	50	25	99.8	0.2
Coal	3.0	683	12877	1265	632.5	95.1	4.9
Oil-Gas	3.0-neg	702	5095	1410	705	86.2	13.8
Gas	neg.	533	1630	0	0	100.0	0
Coal	1.7	1561	16816	401	200.5	98.8	1.2
Oil	2.2	2700	-	7744	3872	-	-
Coal-gas	1.6-0.47	1186	22469	4430	2215	90.1	9.9

Reference: Private correspondence Canada Portland Cement Association.

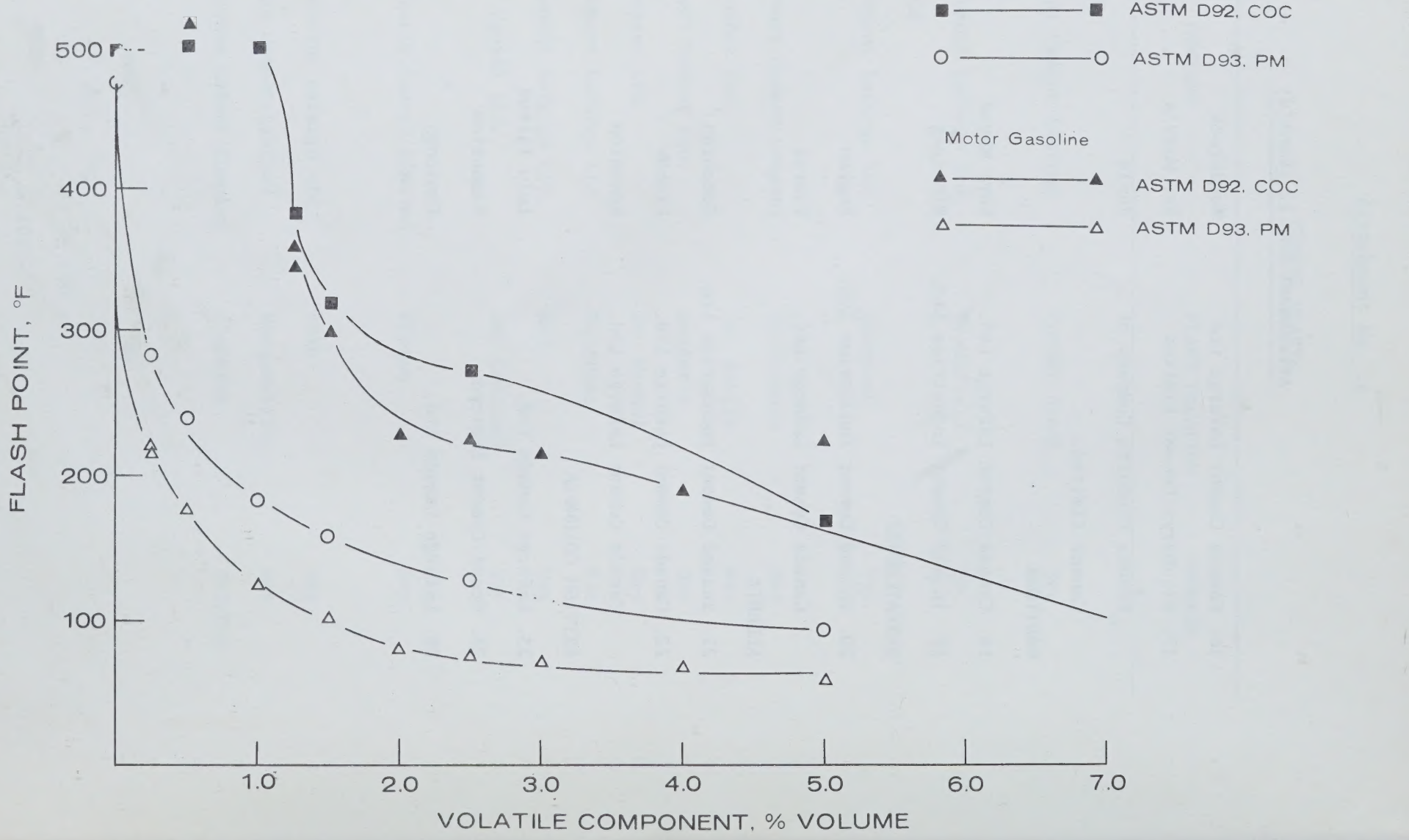
Attachment No. 12

CEMENT PLANTS

COMPANY	PLANT LOCATION	PROCESS
NEWFOUNDLAND		
1. North Star Cement Limited	Corner Brook	Dry
NOVA SCOTIA		
2. Canada Cement Lafarge Ltd.	Brookfield	Dry
NEW BRUNSWICK		
3. Canada Cement Lafarge Ltd.	Havelock	Dry
QUEBEC		
4. St. Lawrence Cement Company	Villeneuve	Wet
5. Cement Quebec Inc.	St. Basile	Wet
6. Independent Cement Inc.	Joliette	Dry
7. Miron Company Ltd.	St. Michel	Dry
8. Canada Cement Lafarge Ltd.	Montreal	Wet
9. Canada Cement Lafarge Ltd.	Hull	Wet
10. Lafarge Canada Ltd.	St. Constant	Dry
ONTARIO		
11. Lake Ontario Cement Limited	Picton	Dry
13. Canada Cement Lafarge Ltd.	Bath	Dry
14. St. Marys Cement Limited	Bowmanville	Wet
15. St. Lawrence Cement Company	Clarkson	Wet/Dry

16. Canada Cement Lafarge Ltd.	Woodstock	Wet
17. St. Marys Cement Limited	St. Mary's	Wet
Medusa Products Company of Canada Limited.	Paris	
MANITOBA		
18. Canada Cement Lafarge Ltd.	Fort Whyte	Wet
19. Inland Cement Industries Ltd.	Winnipeg	Wet
SASKATCHEWAN		
20. Inland Cement Industries Ltd.	Regian	Dry
Canada Cement Lafarge Ltd.	Floral	
ALBERTA		
21. Inland Cement Industries Ltd.	Edmonton	Wet
22. Canada Cement Lafarge Ltd.	Exshaw	Wet
Canada Cement Lafarge Ltd.	Edmonton	
BRITISH COLUMBIA		
23. Lafarge Canada Ltd.	Lulu Island	Wet
24. Ocean Cement Limited	Bamberton	Wet
25. Lafarge Canada Ltd.	Kamloops	Dry

EFFECT OF VOLATILE PETROLEUM PRODUCTS
ON THE
FLASH POINTS OF LUBRICATING OIL



Attachment No. 14

METAL CONTENT OF ACID SLUDGE

Element		Gasoline[1]	Diesel[1]	E.P.A.[2]
Lead	Pb	20,000	1,000	19,000
Calcium	Ca	6,400	12,000	-
Phosphorus	P	4,300	1,000	1,700
Sodium	Na	4,000	200	-
Zinc	Zh	2,100	200	2,100
Silicon	Si	1,400	800	-
Barium	Ba	1,300	400	740
Iron	Fe	1,100	500	2,200
Magnesium	Mg	1,000	70	-
Aluminum	Al	140	40	560
Chromium	Cr	50	190	28
Boron	B	50	40	18
Copper	Cu	40	40	190
Nickel	Ni	30	35	-
Tin	Sn	30	35	-
Silver	Ag	0	14	0.8
Manganese	Mn	-	-	63
Arsenic	As	-	-	45
Molybdenum	Mo	-	-	18
Vanadium	V	-	-	18
Cadmium	Cd	-	-	9
Strontium	Sr	-	-	2.7
Cobalt	Co	-	-	0.8
Beryllium	Be	-	-	0.1

	Other Analysis [1]	
Sulphur %	14.9	14.1
Ash SO_4	4.45	11.26
Acid % (as H_2SO_4)	47.5	40.8

	Additional Information [1]		
Sulphur S	13.5	-	14.5%
Titratable Acid	40	-	45%
Ash	5	-	15%
Combustibles	30	-	42%
Viscosity @ 75°F	4,000,000 centistokes		
Viscosity @105°F	475,000	"	
Viscosity @125°F	150,600	"	
pH	Oil		
Weight	12-16/gal		

NOTES:

(1) Analysis obtained from re-refinery - private correspondence

(2) EPA Report "Waste Oil Study Preliminary Report to the Congress, April 1973".

Attachment No. 15

GENERAL CLASSIFICATION OF OILS

Re-refinable (1)	Non Re-refinable (2)
i) All diesel and gasoline crankcase oils	i) fatty oils
ii) crusher oils	ii) asphaltic oils
iii) drier bearing oils	iii) black oils
iv) compressor oils	iv) bunker oils
v) hydraulic oils	v) metal working oils containing fatty oils
vi) gear oils (non-fatty)	vi) soluble oils
vii) cylinder oils (non-fatty)	
viii) machine oils (non-fatty)	
ix) grinding oils (non-fatty)	
x) quenching oils (non-fatty)	
xi) transformer oil	
xii) turbine oils (non-fatty)	

1) Re-refinable can be recycled to base lube oil stock by conventional acid/clay process.

2) Non-re-refinable oils cannot be handled by conventional acid/clay process.

Attachment No. 16

POSSIBLE COLLECTION PLANS FOR RAILWAY YARD

PLAN	Storage Facilities		Recycled Product or End-Use			
	No. of Tanks	Tank Contents	Material for fuel[1] or Incineration	Custom Blended Lube Oil[2] Car Journal	Diesel Crankcase	Automotive Crankcase
A	1	all used lube oil &/ organic liquids	X			
B	2	all used lube oil		X		
		all other organic liquids	X			
C	2	used diesel crankcase oil			X	
		all other organic liquids	X			
D	2	used diesel and automotive crankcase lube oil		X		X
		all other organic liquids	X			
E	3	used diesel crankcase oil			X	
		all other used lube oil		X		
		all other organic liquids	X			

NOTE: 1 - use as fuel will depend upon degree of contamination (BS&W) and flash point.

2 - custom blended lube oil - made of re-refined base stock lube oil formulated with required additive package to meet company specifications.

Attachment No. 17

COMPOSITION, APPLICATION AND FUNCTION OF LUBRICATING OIL ADDITIVES

Name of Additive	Composition	Application	Function
Corrosion Inhibitor	Zn and Ba dithiophosphates, dithiocarbamates, metal sulfonates and sulfurized terpenes	IC engines, alloy bearings, ATF	To react with metal surfaces to form a corrosion-resistant film
Rust Inhibitor	Sulfonates, alkylamines, amine phosphates, alkenylsuccinic acids, fatty acids and acid phosphate esters	IC engines, turbines, electric and mechanical rotary machiner, fire-resistant hydraulic fluids	To react chemically with steel surfaces to form an impervious film
Antiodorant	Perfumes, formaldehyde compounds	With EP additives	To mask odors
Antiseptic	Alcohols, phenols, chlorine compounds	With water added to oil-emulsions	To inhibit microorgansims
Antioxidant	Sulfides, phosphites, amines, phenols, dithiophosphates	IC engines, turbines, and rotary machinery	To inhibit oxidation of oil
Antifoam	Silicones, synthetic polymers, waxes	Same as rust inhibitors, excluding ball bearings	To permit air bubbles to separate from oil
Detergent	Sulfonates, phosphonates, phenates, alkyl substituted salicylates combined with barium, magnesium, zinc calcium	IC engines under steady load	To neutralize acids in crankcase oils to form compounds suspended in oil
Dispersant	Alkenyl succinimides, alkyl-acrylic polymers, ashless compounds	IC engines at low temperatures and variable loads	To disperse contaminants in the lubricant

Abbreviations: IC = Internal Combustion Engine; ATF = Automatic Transmission Fluid; EP = Extreme Pressure

Attachment No. 17 (Cont'd)

COMPOSITION, APPLICATION AND FUNCTION OF LUBRICATING OIL ADDITIVES

Name of Additive	Composition	Application	Function
Metal Deactivator	Organic dihydroxyphosphines, phosphites and sulfur compounds	IC engines, turbines, electric motors, air compressors, hydraulic oils	To form protective film on running surfaces to inhibit corrosion reactions
Color Stabilizer	Amine compounds	When heat and oxidation darken oil	To stabilize oil color
Viscosity index Improver	Isobutylene polymers and acrylate copolymers	IC engines, electric motors, air compressors, hydraulic oils	To retard loss of viscosity at high temperatures
Pour Point Depressant	Polymethacrylates, polyacrylamides, alkylated naphthalenes and phenols	IC engines, gears, bearings, transmissions	To prevent congealing of oil at low temperatures
Extreme Pressure Additive	Organic compounds with sulfur, phosphorous, nitrogen, halogens, carboxyl or carboxalate salt	IC engines, turbines, motors hydraulic oils, gears, rollers and ball bearings	To form low-shear-strength film providing lubrication at startup and at high bearing loads
Antiwear Additive	Chlorinated waxes, organic phosphates, lead naphthenate	As above	As above except for running condition
Tackiness Agent	Polyacrylates and polybutenes	Gear enclosures from which oil must not drop	To improve adhesive qualities of base oil
Emulsifier	Surfactants, sulfonates, naphthenates and fatty acid soaps	Soluble cutting oils	To reduce interfacial tension and permit formation of water-oil emulsion

Abbreviations: IC = Internal Combustion Engine: ATF = Automatic Transmission Fluid; EP = Extreme Pressure

Attachment No. 18 (61)

SUMMARY OF CRANKCASE WASTE OIL PROCESSES

Process	Primary Product	Primary Wastes & Byproducts	Grass Roots Econ. % Million Gal/Yr Investment	Op. Cost *	Comments
Acid/Clay	Lube blending stock	Acid sludge, spent clay	$1,153,000	21.9¢/Gal Lube	Widely used in U.S.
Extraction/ Acid/Clay	Lube blending stock	Acid sludge, spent clay; high ash fuel byproduct	$1,363,000	18.4¢/Gal Lube	One operating plant in Italy.
Distillation/ Clay	Lube blending stock	Spent clay; high ash fuel byproduct	$1,173,000	17.3¢/Gal Lube	At least two plants in U.S.
Distillation/ H_2 Treating	Lube blending stock	High ash fuel byproduct	$1,342,000	19.0¢/Gal Lube	Under development.
Distillation	Fuel oil	High ash fuel byproduct	$ 930,000	15.1¢/Gal Fuel oil	Can make high quality fuel, but economics questionable.

* Includes 10%/Yr depreciation, but excludes return on investment.
Based on raw oil feed of SM US gal/yr operating 250 days per year as American cents/VS gal

Attachment No. 19

Examples of Existing Provincial Legislation

Province							
Newfoundland Labrador	Provincial Affairs & Environmental Act, 1973	The Dept. of Public Health Act	The Water Protection Act, 1974	The Local Government Act	Common Law	Waste Material Disposal Act, 1973	The Nuisances & Municipal Regulations Act
Nova Scotia	Environmental Pollution Control Act	The Public Health Act	The Water Act	The Municipal Act	Common Law		
New Brunswick	Clean Environment Act	The Health Act	The Water Act	The Municipal Act	Common Law		
Prince Edward Island	Environmental Control Commission Act	The Public Health Act		The Towns Act	Common Law	The Factories Act	The Fish and Game Protection Act

- A digest of Environmental Pollution Legislation in Canada, 1973, Water - compiled by Canadian Industries Limited.

Attachment No. 20

ESTIMATING METHODS FOR DETERMINING AUTOMOTIVE LUBRICATING OIL VOLUMES

1) No. of Registered Vehicles in Canada (59) — 9.7 MM

Quarts of oil per change — 4

No. of changes per year (4) — 3

Yield from change — 90%

Total automotive used oil available:

$$9.7 \times 10^6 \times 4 \times 1/4 \times 3 \times 0.90 = \underline{26 \text{ MM gal /yr}}$$

2) If it is assumed that 30 percent (2) of the people in Canada change their own car oil, the recoverable yield from this source would be:

$$9.7 \times 10^6 \times 4 \times 1/4 \times 3 \times .90 \times .30 = \underline{8 \text{ MM gal /yr}}$$

3) A recent study (45) in Vermont, used 3 1/2 changes per year which would give 30 MM gal /yr

4) Waste oil collectors find on the average 1,000 gal /yr /service station (16). Using 35.142 total automotive oil sales outlets (44), the total used oil would be:

$$35.0 \times 10^3 \times 10^3 = \underline{35 \text{ MM gal /yr}}$$

5) PACE ** carried out a study (4) based on 1970 sales and found about one gallon of used oil per person per year from service station sales only. based on the 1972 population (1), the quantity of used automotive oil available using this calculation method would be: 22 MM gal /yr

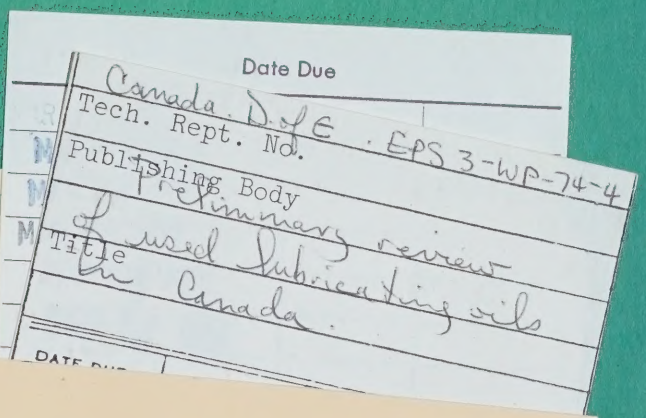
6) A study (6) by the National Research Council on the Ottawa City buses gave the following overall recovery factor:

Quarts of oil in oil pan:	22
Interval between oil changes:	8,000 (average) miles
Oil consumption:	4 qt /1,000 miles 32 qt between changes

** PACE - Petroleum Association for the Conservation of the Canadian Environment.

Attachment No. 20 (cont'd)

Yield from oil pan:	80%
Overall recovery factor:	$\frac{22 \times 0.80}{22 + 32} = 33\%$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